Standard Specifications for Road and Bridge Construction

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
CARSON CITY
1986

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Standard Specifications for Road and Bridge Construction

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TABLE OF CONTENTS

DIVISION 1—GENERAL REQUIREMENTS

SECTION 101—DEFINITIONS AND TERMS

		PAGE
101.01	Abbreviations	1
101.02	Advertisement	2
101.03	Award	2
101.04	Base Course	2
101.05	Bidder	2
101.06	Bridge	2
101.07	Calendar Day	2
101.08	Contract Change Order	2
101.09	Channel	2
101.10	Contract	2
101.11	Contract Bond	3
101.12	Contract Item (Pay Item)	3
101.13	Contractor	3
101.14	Contract Time	3
101.15	Culvert	3
101.16	Department	3
101.17	Detour	3
101.18	Directors	4
101.19	Divided Highways	4
101.20	Employee	4
101.21	Engineer	4
101.22	Equipment	4
101.23	Extra Work	4
101.24	Frontage Road or Frontage Street	4
101.25	Highway	4
101.26	Holidays	4
101.27	Inspector	5
101.28	Laboratory	5
101.29	Major Contract Item	5
101.30	Materials	5
101.31	Median	5
101.32	Notice to Contractors	5
101.33	Notice to Proceed	5
101.34	Pavement Structure	5
101.35	Plans	5
101.36	Profile Grade	5
101.37	Project	5
101.38	Proposal	6
101.39	Proposal Form	6
101.40	Proposal Guaranty	6
101.41	Right of Way	6

CONTENTS

GENERAL REQUIREMENTS—*Continued*

		PAGE
101.42	Road	6
101.43	Roadbed	6
101.44	Roadside	6
101.45	Roadside Development	6
101.46	Roadway	6
101.47	Shoulder	6
101.48	Sidewalk	6
101.49	Special Provisions	6
101.50	Specifications	6
101.51	State	7
101.52	Street	7
101.53	Structures	7
101.54	Subcontractor	7
101.55	Subgrade	7
101.56	Substructure	7
101.57	Superintendent	7
101.58	Superstructure	7
101.59	Supplemental Agreement	7
101.60	Supplemental Specifications	7
101.61	Surety	7
101.62	Surface Course	7
101.63	Traffic Lane	8
101.64	Traveled Way	8
101.65	Work	8
101.66	Working Day	8
101.67	Working Drawings	8
101.68		8

SECTION 102—BIDDING REQUIREMENTS AND CONDITIONS

102.01	Notice to Contractors	9
102.02	Prequalification of Bidders	9
102.03	Contents of Proposal Forms	9
102.04	Interpretation of Quantities in the Proposal	10
102.05	Examination of Plans, Specifications, Contract Documents and Site Work	10
102.06	Preparation of Proposal	11
102.07	Irregular Proposals	11
102.08	Proposal Guaranty	12
102.09	Delivery of Proposals	12
102.10	Withdrawal or Revision of Proposals	12
102.11	Public Opening of Proposals	12
102.12	Disqualification of Bidders	12
102.13	Material Guaranty	13
102.14	Combination or Conditional Bids	13
102.15	Motor Fuel Tax Refund	13

GENERAL REQUIREMENTS—*Continued*

SECTION 103—AWARD AND EXECUTION OF CONTRACT

		PAGE
103.01	Consideration of Proposals	15
103.02	Award of Contract	15
103.03	Cancellation of Award	15
103.04	Return of Proposal Guaranty	15
103.05	Requirement of Contract Bond	16
103.06	Execution and Approval of Contract	16
103.07	Failure to Execute Contract	16

SECTION 104—SCOPE OF THE WORK

104.01	Intent of the Contract	17
104.02	Increased or Decreased Quantities and Change in Character of Work	17
104.03	Extra Work	18
104.04	Maintenance of Traffic	18
104.05	Rights in and Use of Materials Found on the Work	20
104.06	Final Clean Up	20

SECTION 105—CONTROL OF WORK

105.01	Authority of the Engineer	23
105.02	Plans and Working Drawings	23
105.03	Conformity With Plans and Specifications	24
105.04	Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions	24
105.05	Cooperation by Contractor	24
105.06	Cooperation with Utilities	25
105.07	Cooperation Between Contractors	26
105.08	Construction Stakes, Lines and Grades	26
105.09	Authority and Duties of the Resident Engineer	26
105.10	Duties of the Inspector	26
105.11	Inspection	27
105.12	Removal of Unacceptable and Unauthorized Work	27
105.13	Load and Speed Restrictions	28
105.14	Maintenance During Construction	28
105.15	Failure to Maintain Roadway or Structure	28
105.16	Final Acceptance	28
105.17	Claims for Adjustments and Disputes	29
105.18	Value Engineering Proposals	29

SECTION 106—CONTROL OF MATERIAL

106.01	Source of Supply and Quality Requirements	33
106.02	Local Materials	33
106.03	Possible Local Material Sources	35
106.04	Samples and Tests	43
106.05	Certificates of Compliance	45

CONTENTS

GENERAL REQUIREMENTS—*Continued*

		PAGE
106.06	Cited Specifications	45
106.07	Plant Inspection	46
106.08	Storage of Materials	46
106.09	Handling Materials	46
106.10	Unacceptable Materials	46
106.11	Department Furnished Material	47

SECTION 107—LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01	Laws to be Observed	49
107.02	Permits, Licenses, and Taxes	49
107.03	Patented Devices, Materials, and Processes	49
107.04	Restoration of Surfaces Opened by Permit	49
107.05	Federal Aid Provisions	50
107.06	Sanitary Health and Safety Provisions	50
107.07	Public Convenience and Safety	50
107.08	Relations with Railroad	51
107.09	Liability Insurance	53
107.10	Explosives	54
107.11	Responsibility for Damage Claims	55
107.12	Protection and Restoration of Property and Landscape	55
107.13	Forest Protection	57
107.14	Disposal of Material Outside Highway Right of Way	57
107.15	Relief from Maintenance and Responsibility	58
107.16	Contractor's Responsibility for the Work and Materials	59
107.17	Contractor's Responsibility for Utility Property and Service	59
107.18	Furnishing Right of Way	61
107.19	Personal Liability of Public Officials	61
107.20	No Waiver of Legal Rights	61
107.21	Dust Control	61

SECTION 108—PROSECUTION AND PROGRESS

108.01	Subletting of Contract	63
108.02	Notice to Proceed	64
108.03	Prosecution and Progress	64
108.04	Limitation of Operations	64
108.05	Character of Workmen; Methods and Equipment	65
108.06	Temporary Suspension of Work	66
108.07	Preconstruction Conference	67
108.08	Determination and Extension of Contract Time	67
108.09	Failure to Complete the Work on Time	69
108.10	Default and Termination of Contract	69
108.11	Termination of the Contractor's Responsibility	71
108.12	Right of Way Delays	71
108.13	National Emergency and Termination of Contract	71

GENERAL REQUIREMENTS—*Continued*

SECTION 109—MEASUREMENT AND PAYMENT

PAGE
109.01 Measurement of Quantities ... 73
109.02 Scope of Payment ... 78
109.03 Extra and Force Account Work ... 79
109.04 Eliminated Items ... 81
109.05 Common Carrier Rate Adjustments ... 81
109.06 Partial Payment ... 82
109.07 Acceptance and Final Payment ... 86

SECTION 110—WAGES AND CONDITIONS OF EMPLOYMENT

110.01 Description ... 89
110.02 Laws Cited ... 89

DIVISION II—CONSTRUCTION DETAILS

SECTION 201—CLEARING AND GRUBBING

Description
201.01.01 General ... 91
Construction
201.03.01 General ... 91
201.03.02 Areas to be Cleared ... 91
201.03.03 Clearing and Grubbing ... 92
201.03.04 Rural Clearing ... 93
201.03.05 Urban Clearing ... 93
Method of Measurement
201.04.01 Measurement ... 94
Basis of Payment
201.05.01 Payment ... 94

SECTION 202—REMOVAL OF STRUCTURES AND OBSTRUCTIONS

Description
202.01.01 General ... 97
Construction
202.03.01 General ... 97
202.03.02 Removal ... 97
202.03.03 Extensions ... 98
202.03.04 Closing Culverts ... 98
202.03.05 Salvage ... 99
202.03.06 Disposing of Materials ... 99
Method of Measurement
202.04.01 Measurement ... 100
Basis of Payment
202.05.01 Payment ... 100

CONTENTS

CONSTRUCTION DETAILS—*Continued*

SECTION 203—EXCAVATION AND EMBANKMENT

		PAGE
Description		
203.01.01	General	101
Materials		
203.02.01	Roadway Excavation	101
203.02.02	Drainage Excavation	101
203.02.03	Channel Excavation	101
203.02.04	Borrow	101
203.02.05	Selected Borrow	101
Construction		
203.03.01	Roadway	102
203.03.02	Unsuitable Material	102
203.03.03	Blasting	102
203.03.04	Rock Cuts	102
203.03.05	Overbreak	103
203.03.06	Slopes	103
203.03.07	Widening Cuts	103
203.03.08	Surplus Material	103
203.03.09	Selected Material	104
203.03.10	Slides and Slipouts	104
203.03.11	Drainage	105
203.03.12	Channels	105
203.03.13	Borrow	105
203.03.14	Foundation	106
203.03.15	Embankment Material	107
203.03.16	Placing Embankment	107
203.03.17	Compaction, Dirt Embankment	109
203.03.18	Compaction, Rock Embankment	110
203.03.19	Maintenance	112
Method of Measurement		
203.04.01	Measurement	113
Basis of Payment		
203.05.01	Payment	115

SECTION 204—ROUNDED AND TRANSISTION SLOPES

Description		
204.01.01	General	117
Construction		
204.03.01	General	117
Method of Measurement		
204.04.01	Measurement	117
Basis of Payment		
204.05.01	Payment	117

CONSTRUCTION DETAILS—*Continued*

SECTION 205—OVERHAUL

Description PAGE
205.01.01 General ... 119

Method of Measurement
205.04.01 Measurement ... 119

Basis of Payment
205.05.01 Payment ... 119

SECTION 206—STRUCTURE EXCAVATION

Description
206.01.01 General ... 121
206.01.02 Classification ... 121

Construction
206.03.01 General ... 121
206.03.02 Inspection ... 122

Method of Measurement
206.04.01 Measurement ... 122

Basis of Payment
206.05.01 Payment ... 123

SECTION 207—BACKFILL

Description
207.01.01 General ... 125

Materials
207.02.01 Backfill ... 125
207.02.02 Granular Backfill ... 125

Construction
207.03.01 General ... 126
207.03.02 Placing and Compacting at Abutments, Piers, Wingwalls, and Retaining Walls ... 126
207.03.03 Placing and Compacting at Culverts ... 127
207.03.04 Placing and Compacting of Bin-Type Retaining Walls ... 127

Method of Measurement
207.04.01 Measurement ... 127

Basis of Payment
207.05.01 Payment ... 127

SECTION 208—FOUNDATION FILL

Description
208.01.01 General ... 129

Materials
208.02.01 General ... 129

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Construction PAGE

208.03.01 General 129

Method of Measurement

208.04.01 Measurement 129

Basis of Payment

208.05.01 Payment 129

SECTION 209—DRAIN BACKFILL

Description

209.01.01 General 131

Materials

209.02.01 General 131

Construction

209.03.01 Underdrains 131

Method of Measurement

209.04.01 Measurement 131

Basis of Payment

209.05.01 Payment 131

SECTION 210—WATERING

Description

210.01.01 General 133

Materials

210.02.01 General 133

Construction

210.03.01 Equipment 133

210.03.02 General 133

Method of Measurement

210.04.01 Measurement 134

Basis of Payment

210.05.01 Payment 134

SECTION 211—EROSION CONTROL

Description

211.01.01 General 135

Materials

211.02.01 General 135

211.02.02 Top Soil 135

211.02.03 Seed 135

211.02.04 Fertilizer 135

211.02.05 Mulch 135

211.02.06 Tackifier 136

CONSTRUCTION DETAILS—*Continued*

		PAGE
Construction		
211.03.01	Preparation	136
211.03.02	Placement of Top Soil	136
211.03.03	Compaction	136
211.03.04	Seeding and Fertilizing	137
211.03.05	Spreading Mulch	138
211.03.06	Applying Tackifier	138
211.03.07	Placing Erosion Control Fabric	138
Method of Measurement		
211.04.01	Measurement	139
Basis of Payment		
211.05.01	Payment	139

SECTION 212—LANDSCAPING

Description		
212.01.01	General	141
Materials		
212.02.01	General	141
212.02.02	Nomenclature	141
212.02.03	Quality of Plant Materials	141
212.02.04	Handling and Shipping	142
212.02.05	Inspection of Plant Material	142
212.02.06	Subtitution of Plants	143
212.02.07	Temporary Storage	143
212.02.08	Lumber	143
Construction		
212.03.01	Site Preparation	143
212.03.02	Layout of Planting	143
212.03.03	Preparation of Planting Areas	144
212.03.04	Planting	145
212.03.05	Staking and Guying	147
212.03.06	Pruning	147
212.03.07	Watering	147
212.03.08	Replacements	148
212.03.09	Fertilizers and Additives	149
212.03.10	Protection of Existing Facilities	149
212.03.11	Plant Establishment Work	149
Method of Measurement		
212.04.01	Measurement	149
Basis of Payment		
212.05.01	Payment	150

SECTION 213—IRRIGATION SYSTEMS

Description		
213.01.01	General	153

CONTENTS

CONSTRUCTION DETAILS—*Continued*

PAGE

Materials

213.02.01 General ... 153
213.02.02 Bedding and Backfilling ... 153
213.02.03 Control Tubing ... 154
213.02.04 Automatic Controllers ... 154
213.02.05 Sprinkler Heads ... 154
213.02.06 Valve Protection Sleeves ... 154
213.02.07 Gate Valves ... 155
213.02.08 Control Valves ... 155
213.02.09 Quick Coupler Valves ... 155
213.02.10 Valve Boxes ... 156
213.02.11 Backflow Preventers ... 156
213.02.12 Drain Valves ... 156
213.02.13 Hose Bibs ... 156
213.02.14 Vacuum Breakers ... 156
213.02.15 Air Relief Valve ... 157

Construction

213.03.01 General ... 157
213.03.02 Excavation ... 157
213.03.03 Excavation Adjacent to Trees ... 158
213.03.04 Piping ... 158
213.03.05 Jointing ... 158
213.03.06 (Blank)
213.03.07 Installation ... 158
213.03.08 Control Tubing Installation ... 160
213.03.09 Flushing and Testing ... 160
213.03.10 Adjusting System ... 161
213.03.11 Backfill ... 161

Method of Measurement

213.04.01 Measurement ... 161

Basis of Payment

213.05.01 Payment ... 161

SECTION 301—SELECTED MATERIAL BASE OR SURFACE

Description

301.01.01 General ... 163

Materials

301.02.01 General ... 163

Construction

301.03.01 Subgrade Preparation ... 163
301.03.02 Placing ... 163
301.03.03 Watering ... 163
301.03.04 Compaction ... 163

Method of Measurement

301.04.01 Measurement ... 164

CONSTRUCTION DETAILS—*Continued*

Basis of Payment PAGE
301.05.01 Payment ... 164

SECTION 302—AGGREGATE BASE COURSES

Description
302.01.01 General ... 165

Materials
302.02.01 General ... 165

Construction
302.03.01 Subgrade Preparation ... 165
302.03.02 Spreading Class A Aggregates ... 165
302.03.03 Spreading Class B Aggregates ... 166
302.03.04 Watering and Mixing Class A Aggregates ... 167
302.03.05 Watering Class B Aggregates ... 167
302.03.06 Compaction ... 167
302.03.07 Tolerance for Type 2 Class A Aggregate ... 167

Method of Measurement
302.04.01 Measurement ... 168

Basis of Payment
302.05.01 Payment ... 168

SECTION 303—PLANTMIX BITUMINOUS BASE

Description
303.01.01 General ... 169

Materials
303.02.01 General ... 169

Construction
303.03.01 General ... 169
303.03.02 Rollers ... 169
303.03.03 Spreading and Finishing ... 169
303.03.04 Surface Tolerances ... 169

Method of Measurement
303.04.01 Measurement ... 170

Basis of Payment
303.05.01 Payment ... 170

SECTION 304—PORTLAND CEMENT TREATED BASE

Description
304.01.01 General ... 171

Materials
304.02.01 General ... 171

CONTENTS

CONSTRUCTION DETAILS—*Continued*

		PAGE
Construction		
304.03.01	Proportioning	171
304.03.02	Mixing—Roadmix Method	171
304.03.03	Mixing—Plantmix Method	173
304.03.04	Spreading	174
304.03.05	Compaction	176
304.03.06	Finished Surface	177
304.03.07	Time Requirements	177
304.03.08	Construction Joints	177
304.03.09	Protection and Curing	177
304.03.10	Weather Limitations	178
Method of Measurement		
304.04.01	Roadmix Method Designated for Use	178
304.04.02	Plantmix Method Designated for Use	179
304.04.03	General	179
Basis of Payment		
304.05.01	Roadmix Method Designated for Use	179
304.05.02	Plantmix Method Designated for Use	180
304.05.03	General	180

SECTION 305—ROADBED MODIFICATION

Description		
305.01.01	General	181
Materials		
305.02.01	General	181
305.02.02	Gradation Requirements	181
Construction		
305.03.01	Weather Limitations	181
305.03.02	Preparation of Roadbed	181
305.03.03	Proportioning	182
305.03.04	Mixing	182
305.03.05	Compacting and Finishing	183
305.03.06	Protection and Curing	183
Method of Measurement		
305.04.01	Measurement	183
305.04.02	General	184
Basis of Payment		
305.05.01	Payment	184

SECTION 307—SHOULDERING MATERIAL

Description		
307.01.01	General	185
Materials		
307.02.01	General	185
307.02.02	Gradation Requirements	185

CONSTRUCTION DETAILS—*Continued*

Construction PAGE

307.03.01 Compaction ... 185

Method of Measurement

307.04.01 Measurement ... 185

Basis of Payment

307.05.01 Payment ... 185

SECTION 401—PLANTMIX BITUMINOUS PAVEMENTS—GENERAL

Description

401.01.01 General ... 187

Materials

401.02.01 Composition of Mixtures ... 187
401.02.02 Aggregates ... 189
401.02.03 Commercial Mineral Filler ... 189
401.02.04 Bituminous Materials ... 189
401.02.05 Pavement Reinforcing Fabric ... 189

Construction

401.03.01 Bituminous Mixing Plant ... 189
401.03.02 Hauling Equipment ... 196
401.03.03 Pavers ... 197
401.03.04 Rollers ... 197
401.03.05 Weather Limitations ... 198
401.03.06 Preparation of Existing Surface ... 198
401.03.07 Preparation of Bituminous Materials ... 198
401.03.08 Preparation of Aggregates ... 198
401.03.09 Mixing ... 200
401.03.10 Spreading and Finishing ... 200
401.03.11 Rolling ... 201
401.03.12 Joints ... 202
401.03.13 Surface Tolerances ... 202
401.03.14 Surfacing Miscellaneous Areas ... 202
401.03.15 Pavement Reinforcing Fabric ... 202

Method of Measurement

401.04.01 Measurement ... 203

Basis of Payment

401.05.01 Payment ... 204

SECTION 402—PLANTMIX BITUMINOUS SURFACE

Description

402.01.01 General ... 207

Materials

402.02.01 General ... 207

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Construction PAGE

402.03.01 General ... 207
402.03.02 Rollers ... 207
402.03.03 Spreading and Finishing ... 207
402.03.04 Surface Tolerances ... 208
402.03.05 Recycled Plantmix Bituminous Surface ... 208

Method of Measurement

402.04.01 Measurement ... 209

Basis of Payment

402.05.01 Payment ... 210

SECTION 403—PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

Description

403.01.01 General ... 211

Materials

403.02.01 General ... 211

Construction

403.03.01 General ... 211
403.03.02 Rollers ... 211
403.03.03 Joints ... 212
403.03.04 Surface Tolerances ... 212

Method of Measurement

403.04.01 Measurement ... 212

Basis of Payment

403.05.01 Payment ... 212

SECTION 404—ROADMIX BITUMINOUS SURFACE

Description

404.01.01 General ... 215

Materials

404.02.01 Aggregates ... 215
404.02.02 Bituminous Material ... 215

Construction

404.03.01 Motor Graders ... 215
404.03.02 Distributors ... 215
404.03.03 Mixing Plants ... 216
404.03.04 Rollers ... 216
404.03.05 Weather Limitations ... 216
404.03.06 Preparation of Existing Surface ... 216
404.03.07 Placing Aggregates ... 216
404.03.08 Application of Bituminous Material ... 217

CONSTRUCTION DETAILS—*Continued*

PAGE
404.03.09 Mixing ... 217
404.03.10 Spreading, Compacting, and Finishing ... 219
404.03.11 Miscellaneous Areas ... 219
404.03.12 Surface Tolerances ... 219
404.03.13 Premixed Bituminous Paving Material ... 220

Method of Measurement

404.04.01 Measurement ... 220

Basis of Payment

404.05.01 Payment ... 221

SECTION 405—TACK COAT

Description

405.01.01 General ... 223

Materials

405.02.01 Bituminous Material ... 223

Construction

405.03.01 Equipment ... 223
405.03.02 Weather Limitations ... 223
405.03.03 Preparation of Surface ... 223
405.03.04 Application of Bituminous Materials ... 224

Method of Measurement

405.04.01 Measurement ... 224

Basis of Payment

405.05.01 Payment ... 224

SECTION 406—PRIME COAT

Description

406.01.01 General ... 225

Materials

406.02.01 Bituminous Material ... 225
406.02.02 Sand Blotter ... 225

Construction

406.03.01 Equipment ... 225
406.03.02 Weather Limitations ... 225
406.03.03 Preparation of Surface ... 225
406.03.04 Application of Bituminous Material ... 225
406.03.05 Application of Blotter Material ... 226

Method of Measurement

406.04.01 Measurement ... 226

Basis of Payment

406.05.01 Payment ... 227

CONTENTS

CONSTRUCTION DETAILS—*Continued*

SECTION 407—SEAL COAT

Description PAGE

407.01.01 General ... 229

Materials

407.02.01 Bituminous Material ... 229
407.02.02 Sand Blotter ... 229

Construction

407.03.01 Equipment ... 229
407.03.02 Weather Limitations ... 229
407.03.03 Preparation of Surface ... 229
407.03.04 Application of Bituminous Material ... 229
407.03.05 Application of Blotter Material ... 230

Method of Measurement

407.04.01 Measurement ... 230

Basis of Payment

407.05.01 Payment ... 230

SECTION 408—SURFACE TREATEMENT

Description

408.01.01 General ... 231

Materials

408.02.01 Bituminous Material ... 231
408.02.02 Screenings ... 231

Construction

408.03.01 Distributors ... 231
408.03.02 Aggregate Spreader ... 231
408.03.03 Rollers ... 231
408.03.04 Weather Limitations ... 231
408.03.05 Maintaining Traffic ... 231
408.03.06 Preparation of Surface ... 232
408.03.07 Application of Bituminous Material ... 232
408.03.08 Application of Screenings ... 233
408.03.09 Rolling ... 233

Method of Measurement

408.04.01 Measurement ... 233

Basis of Payment

408.05.01 Payment ... 234

SECTION 409—PORTLAND CEMENT CONCRETE PAVEMENT

Description

409.01.01 General ... 235

CONSTRUCTION DETAILS—*Continued*

		PAGE
Materials		
409.02.01	General	235
409.02.02	Gradation Requirements	235
409.02.03	Concrete Properties and Tests	235
409.02.04	Admixtures	237
Construction		
409.03.01	Classification and Proportions	237
409.03.02	Equipment	240
409.03.03	Preparation of Grade	243
409.03.04	Setting Forms	243
409.03.05	Reinforcement	244
409.03.06	Mixing	244
409.03.07	Placing Concrete	244
409.03.08	Spreading, Compacting, and Shaping	245
409.03.09	Joints	247
409.03.10	Finishing	251
409.03.11	Riding Tolerances	252
409.03.12	Curing	253
409.03.13	Protection of Pavement	254
Method of Measurement		
409.04.01	Measurement	255
409.04.02	Pavement Thickness	256
409.04.03	Compressive Strength	258
Basis of Payment		
409.05.01	Payment	259

SECTION 501—PORTLAND CEMENT CONCRETE

Description		
501.01.01	General	261
Materials		
501.02.01	General	261
501.02.02	Gradation Requirements	261
501.02.03	Admixtures	262
501.02.04	Concrete Making Properties	263
Construction		
501.03.01	Equipment	266
501.03.02	Protecting and Sampling Cement	266
501.03.03	Storage of Aggregates	268
501.03.04	Classifications and Proportions	268
501.03.05	Proportioning Methods	269
501.03.06	Machine Mixing	272
501.03.07	Hand Mixing	275
501.03.08	Retempering	275
501.03.09	Curing	275
501.03.10	Weather Limitations	278

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Basis of Payment PAGE

501.05.01 Payment ... 280

SECTION 502—CONCRETE STRUCTURES

Description

502.01.01 General ... 281

Materials

502.02.01 General ... 281

Construction

502.03.01 Depth of Footings ... 281
502.03.02 Forms ... 281
502.03.03 Falsework ... 285
502.03.04 Reinforcement ... 289
502.03.05 Cofferdams and Cribs ... 289
502.03.06 Pumping Water ... 290
502.03.07 Mixing Concrete ... 290
502.03.08 Handling and Placing Concrete ... 290
502.03.09 Pumping Concrete ... 292
502.03.10 Concrete Deposited Under Water ... 292
502.03.11 Construction Joints ... 293
502.03.12 Removal of Falsework and Forms ... 294
502.03.13 Expansion and Fixed Joints and Bearings ... 296
502.03.14 Curing ... 299
502.03.15 Patching ... 299
502.03.16 Finish of Horizontal Surfaces ... 301
502.03.17 Formed Surfaces Requiring Finishing ... 304
502.03.18 Ordinary Surface Finish ... 304
502.03.19 Fine Surface Finish ... 305
502.03.20 Formed Exposed Aggregate Finish ... 306
502.03.21 Live Loads ... 307
502.03.22 Permanent Concrete Barrier Rail ... 307
502.03.23 Portable Precast Concrete Barrier Rail ... 308
502.03.24 Precast Concrete Box Culverts ... 309

Method of Measurement

502.04.01 Measurement ... 310

Basis of Payment

502.05.01 Payment ... 313

SECTION 503—PRECAST PRESTRESSED CONCRETE MEMBERS

Description

503.01.01 General ... 315

Materials

503.02.01 General ... 315

CONSTRUCTION DETAILS—*Continued*

Construction PAGE
503.03.01 General ... 316
503.03.02 Protection of Materials ... 317
503.03.03 Forms ... 318
503.03.04 Anchorages and Distribution ... 318
503.03.05 Ducts ... 319
503.03.06 Prestressing ... 320
503.03.07 Curing ... 323
503.03.08 Bonding and Grouting ... 324
503.03.09 Handling of Precast Members ... 325
503.03.10 Tolerances for Precast Members ... 325

Method of Measurement
503.04.01 Measurement ... 327

Basis of Payment
503.05.01 Payment ... 327

SECTION 504—LIGHTWEIGHT CONCRETE FOR STRUCTURES

Description
504.01.01 General ... 329

Materials
504.02.01 General ... 329
504.02.02 Admixtures ... 329
504.02.03 Concrete Making Properties ... 329

Construction
504.03.01 General ... 330
504.03.02 Storage of Aggregates ... 330
504.03.03 Classification and Proportions ... 330
504.03.04 Mixing ... 332

Method of Measurement
504.04.01 Measurement ... 332

Basis of Payment
504.05.01 Payment ... 334

SECTION 505—REINFORCING STEEL

Description
505.01.01 General ... 335

Materials
505.02.01 General ... 335
505.02.02 Samples ... 336
505.02.03 Specifications for Coating Reinforcing Steel ... 336

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Construction		PAGE
505.03.01	Bending Diagrams	337
505.03.02	Protection of Materials	337
505.03.03	Bending	337
505.03.04	Placing and Fastening	338
505.03.05	Splicing	338
505.03.06	Substitutions	343
Method of Measurement		
505.04.01	Measurement	343
Basis of Payment		
505.05.01	Payment	343

SECTION 506—STEEL STRUCTURES

Description		
506.01.01	General	345
506.01.02	AISC Certification	345
Materials		
506.02.01	General	345
506.02.02	Railing	346
Construction		
506.03.01	Shop Drawings	346
506.03.02	Notice of Beginning Work	347
506.03.03	Inspection and Testing	347
506.03.04	Storage	348
506.03.05	Straightening	349
506.03.06	(Blank)	
506.03.07	(Blank)	
506.03.08	(Blank)	
506.03.09	Punching, Subpunching, Drilling, and Reaming	349
506.03.10	Bolts and Bolted Connections	350
506.03.11	Shop Assembly	352
506.03.12	Edge Planing	353
506.03.13	Facing of Bearing Surfaces	353
506.03.14	Abutting Joints	353
506.03.15	Flame Cutting	353
506.03.16	End Connection Angles	353
506.03.17	Lacing Bars	353
506.03.18	(Blank)	
506.03.19	Shear Stud Connectors	353
506.03.20	Welding	354
506.03.21	Fit of Stiffeners	363
506.03.22	Annealing and Stress Relieving	363
506.03.23	Pins, Rollers and Pin Holes	363
506.03.24	Shop Painting	364
506.03.25	Marking and Shipping	364

CONSTRUCTION DETAILS—*Continued*

PAGE

506.03.26 Erection Methods and Equipment 364
506.03.27 Falsework 365
506.03.28 Bearing and Anchorage 365
506.03.29 Field Assembly 366
506.03.30 Misfits 366
506.03.31 Field Painting 366

Method of Measurement

506.04.01 Measurement 366

Basis of Payment

506.05.01 Payment 367

SECTION 507—TIMBER STRUCTURES

Description

507.01.01 General 369

Materials

507.02.01 General 369

Construction

507.03.01 Storage of Materials 370
507.03.02 Workmanship 370
507.03.03 Treated Timber 370
507.03.04 Untreated Timber 371
507.03.05 Holes for Bolts, Dowels, Rods, and Lag Screws 371
507.03.06 Bolts and Washers 371
507.03.07 Framing 372
507.03.08 Caps 372
507.03.09 Bracing 372
507.03.10 Stringers 372
507.03.11 Plank Floors 373
507.03.12 Laminated Floors 373
507.03.13 Trusses 373
507.03.14 Painting 374
507.03.15 Timber Connectors 374

Method of Measurement

507.04.01 Measurement 374

Basis of Payment

507.05.01 Payment 374

SECTION 508—PILING

Description

508.01.01 General 377

Materials

508.02.01 General 377

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Construction PAGE

508.03.01 Determination of Length ... 377
508.03.02 Test Piles ... 377
508.03.03 Equipment ... 378
508.03.04 Driving of Piles ... 379
508.03.05 Bearing Value and Penetration ... 380
508.03.06 Cutoff and Extensions ... 380
508.03.07 Loading Test ... 381
508.03.08 Timber Piles ... 382
508.03.09 Precast Concrete Piles ... 383
508.03.10 Cast-In-Place Concrete Piles ... 383
508.03.11 Steel Piles ... 388

Method of Measurement

508.04.01 Measurement ... 388

Basis of Payment

508.05.01 Payment ... 389

SECTION 600—PIPE CULVERTS—TYPE OF MATERIAL OPTIONAL

Description

600.01.01 General ... 391

Materials

600.02.01 General ... 391

Construction

600.03.01 General ... 392

Method of Measurement

600.04.01 Measurement ... 392

Basis of Payment

600.05.01 Payment ... 392

SECTION 601—PIPE CULVERTS—GENERAL

Description

601.01.01 General ... 393

Materials

601.02.01 General ... 393

Construction

601.03.01 Earthwork ... 394
601.03.02 Headwalls ... 394
601.03.03 End Sections ... 394
601.03.04 Jacked Pipes ... 394
601.03.05 Laying Culvert Pipe ... 395
601.03.06 Extending Existing Culverts ... 395

CONSTRUCTION DETAILS—*Continued*

Method of Measurement PAGE
601.04.01 Measurement ... 395

Basis of Payment
601.05.01 Payment ... 396

SECTION 602—NONREINFORCED CONCRETE AND CLAY PIPE

Description
602.01.01 General ... 397

Materials
602.02.01 General ... 397

Construction
602.03.01 General ... 397

Method of Measurement
602.04.01 Measurement ... 398

Basis of Payment
602.05.01 Payment ... 398

SECTION 603—REINFORCED CONCRETE PIPE

Description
603.01.01 General ... 399

Materials
603.02.01 General ... 400

Construction
603.03.01 General ... 400
603.03.02 Earthwork ... 400
603.03.03 Laying Culvert Pipe ... 400
603.03.04 Rubber Gasketed Joints ... 402
603.03.05 Siphons and Pressure Pipe ... 402

Method of Measurement
603.04.01 Measurement ... 403

Basis of Payment
603.05.01 Payment ... 403

SECTION 604—CORRUGATED METAL PIPE AND METAL ARCH PIPE

Description
604.01.01 General ... 405

Materials
604.02.01 General ... 405

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Construction PAGE

604.03.01 General ... 406
604.03.02 Laying Culvert Pipe ... 406
604.03.03 Siphons ... 406
604.03.04 Relay Culvert Pipes ... 407
604.03.05 Slotted Drains ... 407

Method of Measurement

604.04.01 Measurement ... 407

Basis of Payment

604.05.01 Payment ... 408

SECTION 605—ALUMINUM CORRUGATED METAL PIPE AND ALUMINUM ARCH CULVERTS

Description

605.01.01 General ... 409

Materials

605.02.01 General ... 409

Construction

605.03.01 General ... 409

Method of Measurement

605.04.01 Measurement ... 409

Basis of Payment

605.05.01 Payment ... 409

SECTION 606—STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

Description

606.01.01 General ... 411

Materials

606.02.01 General ... 411

Construction

606.03.01 Plate Description ... 412
606.03.02 Fabrication ... 412
606.03.03 Field Inspection ... 412
606.03.04 Earthwork ... 413
606.03.05 Assembling ... 413
606.03.06 Strutting ... 414
606.03.07 Workmanship ... 414
606.03.08 Headwalls ... 414
606.03.09 Extending Existing Structural Plate Pipe and Pipe Arch Culverts ... 414

Method of Measurement

606.04.01 Measurement ... 415

CONSTRUCTION DETAILS—*Continued*

Basis of Payment PAGE
606.05.01 Payment ... 415

SECTION 607—UNDERDRAINS

Description
607.01.01 General ... 417

Materials
607.02.01 General ... 417

Construction
607.03.01 Earthwork ... 418
607.03.02 Laying Pipes ... 418
607.03.03 Underdrain Outlets ... 418

Method of Measurement
607.04.01 Measurement ... 418

Basis of Payment
607.05.01 Payment ... 419

SECTION 608—DOWNDRAINS

Description
608.01.01 General ... 421

Materials
608.02.01 General ... 421

Construction
608.03.01 General ... 421

Method of Measurement
608.04.01 Measurement ... 422

Basis of Payment
608.05.01 Payment ... 422

SECTION 609—CATCH BASINS, MANHOLES, AND INLETS

Description
609.01.01 General ... 425

Materials
609.02.01 General ... 425

Construction
609.03.01 General ... 425
609.03.02 Adjusting Catch Basin, Manhole, and Inlet Covers ... 426
609.03.03 Clean Out ... 426
609.03.04 Earthwork ... 427

Method of Measurement
609.04.01 Measurement ... 427

CONSTRUCTION DETAILS—*Continued*

Basis of Payment PAGE
609.05.01 Payment ... 427

SECTION 610—RIPRAP

Description
610.01.01 General ... 429

Materials
610.02.01 General ... 429

Construction
610.03.01 Earthwork ... 430
610.03.02 Light and Medium Riprap ... 430
610.03.03 Heavy Riprap ... 430
610.03.04 Grouted Riprap ... 430
610.03.05 Sacked Concrete Riprap ... 430

Method of Measurement
610.04.01 Measurement ... 431

Basis of Payment
610.05.01 Payment ... 431

SECTION 611—CONCRETE SLOPE PAVING

Description
611.01.01 General ... 433

Materials
611.02.01 General ... 433

Construction
611.03.01 Earthwork ... 433
611.03.02 General ... 434

Method of Measurement
611.04.01 Measurement ... 435

Basis of Payment
611.05.01 Payment ... 435

SECTION 612—METAL BIN-TYPE RETAINING WALLS

Description
612.01.01 General ... 437

Materials
612.02.01 General ... 437

Construction
612.03.01 Fabrication ... 437
612.03.02 Earthwork ... 437
612.03.03 Assembly ... 438

CONSTRUCTION DETAILS—*Continued*

Method of Measurement PAGE
612.04.01 Measurement ... 438

Basis of Payment
612.05.01 Payment ... 438

SECTION 613—CONCRETE CURBS, GUTTERS, AND SIDEWALKS

Description
613.01.01 General ... 439

Materials
613.02.01 General ... 439

Construction
613.03.01 Earthwork ... 439
613.03.02 Existing Curbs, Gutters, and Sidewalks ... 439
613.03.03 Forms ... 440
613.03.04 Curb and Gutter Joints ... 440
613.03.05 Sidewalk Expansion Joints ... 440
613.03.06 Curb and Gutter Construction ... 440
613.03.07 Sidewalk Construction ... 441

Method of Measurement
613.04.01 Measurement ... 442

Basis of Payment
613.05.01 Payment ... 442

SECTION 614—PAINTING

Description
614.01.01 General ... 445

Materials
614.02.01 General ... 445
614.02.02 Number of Coats ... 445

Construction
614.03.01 Weather Conditions ... 445
614.03.02 Application—General ... 446
614.03.03 Surface Preparation of Steel ... 446
614.03.04 Painting Structural Steel ... 448
614.03.05 Painting Timber ... 449

Basis of Payment
614.05.01 Payment ... 449

SECTION 615—PRESERVATIVE TREATMENTS FOR TIMBER

Description
615.01.01 General ... 451

Materials
615.02.01 General ... 451

CONSTRUCTION DETAILS—*Continued*

		PAGE
Construction		
615.03.01	Treatment	451
615.03.02	Amount of Preservative	451
615.03.03	Preservative Treatment by the Hot-Cold Soaking Method	451
615.03.04	Inspection	452
Basis of Payment		
615.05.01	Payment	452

SECTION 616—FENCING

Description		
616.01.01	General	453
Materials		
616.02.01	General	453
Construction		
616.03.01	General	453
616.03.02	Standard Fence	454
616.03.03	Chain-Link Fence	455
616.03.04	Reconstruct Fence	456
616.03.05	Gates	456
Method of Measurement		
616.04.01	Measurement	457
Basis of Payment		
616.05.01	Payment	457

SECTION 617—CATTLE GUARDS

Description		
617.01.01	General	459
Materials		
617.02.01	General	459
Construction		
617.03.01	Earthwork	459
617.03.02	General	459
Method of Measurement		
617.04.01	Measurement	460
Basis of Payment		
617.05.01	Payment	460

SECTION 618—GUARDRAIL

Description		
618.01.01	General	461

CONSTRUCTION DETAILS—*Continued*

Materials PAGE
618.02.01 General ... 461
618.02.02 Reflectors ... 462

Construction
618.03.01 General ... 462
618.03.02 (Blank)
618.03.03 Galvanized Guardrail ... 462
618.03.04 Reconstructed Guardrail ... 463

Method of Measurement
618.04.01 Measurement ... 463

Basis of Payment
618.05.01 Payment ... 463

SECTION 619—OBJECT MARKERS AND GUIDE POSTS

Description
619.01.01 General ... 465

Materials
619.02.01 General ... 465

Construction
619.03.01 General ... 465
619.03.02 Reset ... 465

Method of Measurement
619.04.01 Measurement ... 465

Basis of Payment
619.05.01 Payment ... 465

SECTION 620—RIGHT OF WAY MARKERS

Description
620.01.01 General ... 467

Materials
620.02.01 General ... 467

Construction
620.03.01 General ... 467

Method of Measurement
620.04.01 Measurement ... 467

Basis of Payment
620.05.01 Payment ... 467

SECTION 621—MONUMENTS

Description
621.01.01 General ... 469

CONSTRUCTION DETAILS—*Continued*

Materials PAGE

621.02.01 General ... 469

Construction

621.03.01 Installation ... 469

Method of Measurement

621.04.01 Measurement ... 470

Basis of Payment

621.05.01 Payment ... 470

SECTION 623—SIGNALS AND LIGHTING

Description

623.01.01 General ... 471
623.01.02 Regulations and Code ... 471
623.01.03 Equipment List and Drawings ... 471
623.01.04 Warranties, Guarantees, and Instruction Sheets ... 472
623.01.05 Maintaining Existing and Temporary Electrical Systems ... 472
623.01.06 Scheduling of Work ... 473
623.01.07 Safety Precautions ... 474
623.01.08 Definitions ... 474

Materials and Installation

623.02.01 General ... 476
623.02.02 Foundations ... 476
623.02.02A Excavating and Backfilling ... 477
623.02.03 Removing and Replacing Improvements ... 477
623.02.04 Standards, Steel Pedestals, and Posts ... 478
623.02.05 Conduit ... 480
623.02.06 Pull Boxes ... 483
623.02.07 Expansion Fittings ... 485
623.02.08 Conductors ... 485
623.02.09 Wiring ... 489
623.02.10 Bonding and Grounding ... 492
623.02.11 Service ... 493
623.02.12 Wood Poles ... 495
623.02.13 (Blank)
623.02.14 Field Tests ... 495
623.02.15 Galvanizing ... 496
623.02.16 Painting ... 497
623.02.17 Controllers ... 498
623.02.18 Interval Sequence ... 498
623.02.19 Flashing Operations ... 498
623.02.20 Railroad Pre-emptor ... 498
623.02.21 Railroad Pre-emption Equipment ... 499
623.02.22 Operating Voltage ... 499
623.02.23 Radio Interference Suppressors ... 499
623.02.24 Traffic Actuated Controllers ... 500

CONSTRUCTION DETAILS—*Continued*

PAGE

623.02.25 Traffic Acutuated Controller Cabinet 502
623.02.26 Traffic Pre-empting Devices 506
623.02.27 Local Traffic Computer System Coordination Equipment 510
623.02.28 Time Base Coordination Unit 513
623.02.29 (Blank)
623.02.30 Pre-Timed Controller Units 513
623.02.31 (Blank)
623.02.32 (Blank)
623.02.33 Signal Faces 516
623.02.34 Directional Louvers 518
623.02.35 Back Plates 519
623.02.36 Signal Head Mounting 519
623.02.37 Vehicle Detectors 520
623.02.38 Pedestrian Push Buttons 524
623.02.39 Pedestrian Signals 525
623.02.40 Programmed Visibility Traffic Signal Heads 526
623.02.41 527
623.02.42 527

Lighting

623.03.00 High-Intensity-Discharge Luminaires 527
623.03.01 Mercury Vapor Luminaires 528
623.03.01A High Pressure Sodium Luminaires 529
623.03.02 (Blank)
623.03.03 (Blank)
623.03.04 Incandescent Luminaires 529
623.03.05 Soffit and Wall Luminaires and Lamps 529
623.03.06 (Blank)
623.03.07 Sign Lighting Fixtures—Fluorescent 530
623.03.08 Sign Switches 532
623.03.09 Flashing Beacons 533
623.03.10 Photoelectric Controls 533
623.03.11 (Blank)
623.03.12 Transformers 535
623.03.13 Multiple Circuit Ballasts 537
623.03.14 Falsework Lighting 538
623.03.15 Salvaging Electrical Equipment 540
623.03.16 Reinstalling Salvaged Electrical Equipment 540
623.03.17 Stockpiling Salvaged Electrical Equipment 541

Method of Measurement

623.04.01 Measurement 541

Basis of Payment

613.05.01 Payment 541

SECTION 624—ACCOMMODATIONS FOR PUBLIC TRAFFIC

Description

624.01.01 General 545

CONSTRUCTION DETAILS—*Continued*

Materials PAGE

624.02.01 General ... 545

Construction

624.03.01 Detours ... 545
624.03.02 Flaggers ... 545
624.03.03 Pilot Cars ... 546
624.03.04 Maintain Base ... 546
624.03.05 Equipment Rental ... 547
624.03.06 General ... 547

Method of Measurement

624.04.01 Measurement ... 548

Basis of Payment

624.05.01 Payment ... 548

SECTION 625—CONSTRUCTION SIGNS

Description

625.01.01 General ... 551

Materials

625.02.01 General ... 551
625.02.02 Reflectorization ... 551
625.02.03 Sign Dimensions ... 552

Construction

625.03.01 General ... 552
625.03.02 Sign Placement ... 552
625.03.03 Sign Supports ... 552
625.03.04 Barricades ... 552

Method of Measurement

625.04.01 Measurement ... 553

Basis of Payment

625.05.01 Payment ... 553

SECTION 626—TEMPORARY SIGNS

Description

626.01.01 General ... 555

Materials

626.02.01 General ... 555
626.02.02 Reflectorization ... 555

Construction

626.03.01 General ... 555
626.03.02 Signs ... 555
626.03.03 Traffic Cones ... 556
626.03.04 Barricades ... 556
626.03.05 Remove and Re-erect Temporary Signs or Barricades ... 556

CONSTRUCTION DETAILS—*Continued*

Method of Measurement PAGE
626.04.01 Measurement ... 556

Basis of Payment
626.05.01 Payment ... 557

SECTION 627—PERMANENT SIGNS

Description
627.01.01 General ... 559
627.01.02 Shop Drawings ... 559

Materials
627.02.01 General ... 559
627.02.02 Reflectorization ... 559
627.02.03 Overhead Guide Signs ... 560

Construction
627.03.01 Panel Fastenings ... 560
627.03.02 Closure Strips ... 560
627.03.03 Installation ... 560
627.03.04 Removal ... 561
627.03.05 Reset ... 561
627.03.06 Tests ... 561

Method of Measurement
627.04.01 Measurement ... 561

Basis of Payment
627.05.01 Payment ... 562

SECTION 628—MOBILIZATION

Description
628.01.01 General ... 565

Payment
628.05.01 Payment ... 565

SECTION 633—PAVEMENT MARKERS

Description
633.01.01 General ... 567

Materials
633.02.01 Non-Reflective Pavement Markers ... 567
633.02.02 Reflective Pavement Markers ... 568
633.02.03 Epoxy Adhesive for Pavement Markers ... 568
633.02.04 (Blank)
633.02.05 Tests ... 568

Construction
633.03.01 Installation ... 568

CONSTRUCTION DETAILS—*Continued*

Method of Measurement PAGE
633.04.01 Measurement 569

Basis of Payment
633.05.01 Payment 569

SECTION 634—PAVEMENT MARKING FILM

Description
634.01.01 General 571

Materials
634.02.01 General 571

Construction
634.03.01 General 571

Method of Measurement
634.04.01 Measurement 571

Basis of Payment
634.05.01 Payment 571

SECTION 635—TEMPORARY PAVEMENT STRIPING TAPE

Description
635.01.01 General 573

Materials
635.02.01 General 573

Contruction
635.03.01 General 574

Method of Measurement
635.04.01 Measurement 574

Basis of Payment
635.05.01 Payment 574

SECTION 636—TEMPORARY PAINTED PAVEMENT MARKING

Description
636.01.01 General 577

Materials
636.02.01 General 577

Construction
636.03.01 General 577

Method of Measurement
636.04.01 Measurement 578

CONSTRUCTION DETAILS—*Continued*

Basis of Payment PAGE
636.05.01 Payment ... 578

SECTION 637—POLLUTION CONTROL

Description
637.01.01 General ... 579

Materials
637.02.01 General ... 579

Construction
637.03.01 General ... 579

Method of Measurement
637.04.01 Measurement ... 581

Basis of Payment
637.05.01 Payment ... 581

SECTION 640—RETAINING WALLS

Description
640.01.01 General ... 583

Materials and Installation
640.02.01 Masonry Retaining Wall ... 583
640.02.02 Mechanically Stabilized Earth Wall ... 584

Method of Measurement
640.04.01 Measurement ... 589

Basis of Payment
640.05.01 Payment ... 590

SECTION 646—WATERPROOFING AND DAMPPROOFING

Description
646.01.01 General ... 591

Materials
646.02.01 General ... 591

Construction
646.03.01 General ... 591
646.03.02 Membrane Waterproofing ... 591
646.03.03 Dampproofing ... 592

Method of Measurement
646.04.01 Measurement ... 592

Basis of Payment
646.05.01 Payment ... 592

CONSTRUCTION DETAILS—*Continued*

SECTION 647—BRIDGE DECK WATERPROOFING

		PAGE
Description		
647.01.01	General	593
Materials		
647.02.01	General	593
Construction		
647.03.01	General	595
Method of Measurement		
647.04.01	Measurement	599
Basis of Payment		
647.05.01	Payment	599

SECTION 660—PNEUMATICALLY PLACED CONCRETE MORTAR

Description		
660.01.01	General	601
Materials		
660.02.01	General	601
Construction		
660.03.01	Preparation of Foundation	602
660.03.02	Placing	602
660.03.03	Finishing	603
Method of Measurement		
660.04.01	Measurement	603
Basis of Payment		
660.05.01	Payment	603

DIVISION III—MATERIALS DETAILS

SECTION 701—PORTLAND CEMENT

		PAGE
Scope		
701.01.01	Materials Covered	605
Physical Properties and Tests		
701.03.01	Requirements	605

SECTION 702—CONCRETE CURING MATERIALS AND ADMIXTURES

Scope		
702.01.01	Materials Covered	607
Physical Properties and Tests		
702.03.01	Curing Materials	607
702.03.02	(Blank)	

MATERIALS DETAILS—*Continued*

PAGE

702.03.03 Air-Entraining Admixtures 607
702.03.04 Admixtures Other Than Air-Entraining 607
702.03.05 Hydrated Lime 607
702.03.06 (Blank)
702.03.07 White Pigmented Curing Compound—Chlorinated Rubber Base 608
702.03.08 Pozzolans 609

SECTION 703—BITUMINOUS MATERIAL

Scope

703.01.01 Materials Covered 611

Requirements

703.02.01 Contractor's Responsibility 611
703.02.02 Shipping Notice 611

Physical Properties and Tests

703.03.01 Refinery Test Report 611
703.03.02 Asphalt Cements 612
703.03.03 Liquid Asphalts 615
703.03.04 Emulsified Asphalt 619

SECTION 704—BASE AGGREGATES

Scope

704.01.01 Materials Covered 623

Requirements

704.02.01 General 623
704.02.02 Deficiencies 623
704.02.03 Plastic Limits 623

Physical Properties and Tests

704.03.01 Drain Backfill 624
704.03.02 Type 1 Class A Aggregate Base 624
704.03.03 Type 1 Class B Aggregate Base 624
704.03.04 Type 2 Class A Aggregate Base 625
704.03.05 Type 2 Class B Aggregate Base 625
704.03.06 Type 3 Class A Aggregate 625
704.03.07 Type 3 Class B Aggregate 626
704.03.08 Aggregate for Portland Cement Treated Base 626

SECTION 705—AGGREGATES FOR BITUMINOUS COURSES

Scope

705.01.01 Materials Covered 627

Requirements

705.02.01 General 627
705.02.02 Deficiencies 628

CONTENTS

MATERIALS DETAILS—*Continued*

Physical Properties and Tests

PAGE

705.03.01 Plantmix and Roadmix Bituminous Base and Surface Aggregate, Types 1, 2, and 3 628
705.03.02 Plantmix Surface Aggregate, Type 4 629
705.03.03 Plantmix Bituminous Open-Graded Surface Aggregate 629
705.03.04 Commercial Mineral Filler 630
705.03.05 Screenings 630
705.03.06 Sand Blotter 630

SECTION 706—AGGREGATES FOR PORTLAND CEMENT PRODUCTS

Scope

706.01.01 Materials Covered 631

Requirements

706.02.01 General 631

Physical Properties and Tests

706.03.01 Coarse Aggregates 631
706.03.02 Lightweight Aggregates 633
706.03.03 Fine Aggregate 634
706.03.04 Grout and Mortar Sand 635
706.03.05 Stone for Masonry and Riprap 636

SECTION 707—JOINT MATERIAL

Scope

707.01.01 Material Covered 637

Physical Properties and Tests

707.03.01 Joint Fillers 637
707.03.02 Rubber Gaskets 637
707.03.03 Waterstops 637
707.03.04 Pourable Joint Sealer 638
707.03.05 Asphalt Plank 639
707.03.06 (Blank)
707.03.07 Joint Sealer for Weakened Plane Joints in Portland Cement Concrete Pavements 639

SECTION 708—CONCRETE AND CLAY PIPE AND DRAINS

Scope

708.01.01 Materials Covered 641

Physical Properties and Tests

708.03.01 Reinforced Concrete Pipe 641
708.03.02 Nonreinforced Concrete Pipe 641
708.03.03 Perforated Concrete Pipe 641
708.03.04 Clay Pipe 641
708.03.05 Bituminous Fiber Pipe 641
708.03.06 Perforated Bituminous Fiber Pipe 641
708.03.07 Corrugated Polyethylene Pipe 641

MATERIALS DETAILS—*Continued*

SECTION 709—METAL PIPE AND DRAINS

Scope PAGE

709.01.01 Material Covered ... 643

Physical Properties and Tests

709.03.01 Corrugated Metal Pipe and Pipe Arches ... 643
709.03.02 Bituminous Coated Corrugated Metal Pipe and Pipe Arches ... 643
709.03.03 Corrugated Aluminum Pipe ... 643
709.03.04 Corrugated Metal Pipes for Downdrains ... 643
709.03.05 Corrugated Metal Pipe for Underdrains ... 644
709.03.06 Bituminous Coated Corrugated Metal Pipe for Underdrains ... 644
709.03.07 Corrugated Aluminum Pipe for Underdrains ... 644
709.03.08 Steel Structural Plate Pipe and Pipe Arches ... 644
709.03.09 Aluminum Structural Plate Pipe and Pipe Arches ... 644

SECTION 710—STRUCTURAL STEEL

Scope

710.01.01 Material Covered ... 645

Requirements

710.02.01 Defects ... 645
710.02.02 Charpy V-notch Test ... 645

Physical Properties and Tests

710.03.01 Standard Steel ... 645
710.03.02 High Strength Low Alloy Columbium-Vanadium Steel ... 645
710.03.03 High Strength Bolts ... 645
710.03.04 Stainless Steel Bolts ... 645
710.03.05 Welded Seamless Steel Pipe ... 645
710.03.06 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes ... 646
710.03.07 Shear Stud Connector ... 646
710.03.08 Pins and Rollers ... 646
710.03.09 Bolts ... 646
710.03.10 Structural Steel ... 646
710.03.11 High Strength Low Alloy Steel ... 646
710.03.12 High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding ... 646
710.03.13 High-Yield-Strength Alloy Steel Plates, Quenched and Tempered for Pressure Vessels ... 646

SECTION 711—ALUMINUM FOR BRIDGE RAIL

Scope

711.01.01 Material Covered ... 647

Physical Properties and Tests

711.03.01 Aluminum Alloy for Pipe ... 647

CONTENTS

MATERIALS DETAILS—*Continued*

PAGE

711.03.02 Aluminum Alloy Tubing 647
711.03.03 Cast Aluminum Alloy 647
711.03.04 Aluminum Alloy Shims 647

SECTION 712—MISCELLANEOUS METAL

Scope

712.01.01 Material Covered 649

Physical Properties and Tests

712.03.01 Steel Castings 649
712.03.02 Gray Iron Castings 649
712.03.03 Malleable Castings 649
712.03.04 (Blank)
712.03.05 Bronze Castings 649
712.03.06 Welding Materials 649
712.03.07 Steel Piles 649
712.03.08 Steel Shell for Piles 649

SECTION 713—REINFORCEMENT

Scope

713.01.01 Materials Covered 651

Physical Properties and Tests

713.03.01 Bar Steel Reinforcement 651
713.03.02 Fabricated Steel Bar or Rod Mats Reinforcement 651
713.03.03 Welded Steel Wire Fabric Reinforcement 651
713.03.04 Prestressing Steel 651
713.03.05 Cold-Drawn Steel Wire for Spiral Reinforcement 654

SECTION 714—PAINT

Scope

714.01.01 Materials Covered 655

Requirements

714.02.01 Certificates 655

Physical Properties and Tests

714.03.01 Iron and Steel Use Items 655
714.03.02 Timber Use Items 655
714.03.03 Concrete Use Items 656
714.03.04 Aluminum Use Item 656

SECTION 715—GALVANIZING

Scope

715.01.01 Material Covered 657

Physical Properties and Tests

715.03.01 Products One-eighth (1/8) Inch Thick and Thicker 657
715.03.02 Rail Elements 657
715.03.03 Hardware 657
715.03.04 Mechanical Galvanizing 657

MATERIALS DETAILS—*Continued*

SECTION 716—SIGN MATERIALS

Scope PAGE
716.01.01 Materials Covered ... 659
Requirements
716.02.01 General ... 659
716.02.02 Certificates ... 659
Physical Properties and Tests
716.03.01 Reflective Sheeting ... 659
716.03.02 (Blank)
716.03.03 Aluminum Sign Panels ... 670
716.03.04 (Blank)
716.03.05 Overhead Sign Structures and Sign Frames ... 671
716.03.06 Sign Hardware and Related Materials ... 673

SECTION 717—TIMBER PILES

Scope
717.01.01 Materials Covered ... 677
Requirements
717.02.01 Certificates ... 677
Physical Properties and Tests
717.03.01 General ... 677

SECTION 718—TIMBER

Scope
718.01.01 Materials Covered ... 679
Requirements
718.02.01 Grades ... 679
718.02.02 Certificates of Inspection ... 679
Physical Properties and Tests
718.03.01 Species ... 679
718.03.02 Grades ... 679

SECTION 719—TIMBER PRESERVATIVES

Scope
719.01.01 Materials Covered ... 681
Physical Properties and Tests
719.03.01 Preservatives ... 681

SECTION 720—GUARDRAIL MATERIALS

Scope
720.01.01 Materials Covered ... 683
Requirements
720.02.01 Certificates ... 683

CONTENTS

MATERIALS DETAILS—*Continued*

Physical Properties and Tests PAGE

720.03.01 Rail Members ... 683
720.03.02 Fittings ... 683
720.03.03 Reflector Plates ... 684

SECTION 721—OBJECT MARKERS AND GUIDE POSTS

Scope

721.01.01 Materials Covered ... 685

Requirements

721.02.01 Certificates ... 685

Physical Properties and Tests

721.03.01 Metal Posts ... 685
721.03.02 Target Plates ... 685
721.03.03 Reflectors ... 686

SECTION 722—WATER

Scope

722.01.01 Materials Covered ... 687

Requirements

722.02.01 General ... 687

Physical Properties and Tests

722.03.01 Concrete Use ... 687

SECTION 723—HARDWARE

Scope

723.01.01 Materials Covered ... 689

Physical Properties and Tests

723.03.01 Galvanizing ... 689
723.03.02 Bolts, Nuts, Dowels and Drift Bolts ... 689
723.03.03 Washers ... 689

SECTION 724—FENCE MATERIALS

Scope

724.01.01 Materials Covered ... 691

Requirements

724.02.01 Samples and Certificates of Inspection ... 691

Physical Properties and Tests

724.03.01 Wood Posts ... 691
724.03.02 Metal Posts ... 692
724.03.03 Barbed Wire ... 693
724.03.04 Woven Wire ... 693
724.03.05 Chain-Link Fabric ... 693
724.03.06 Staples, Brace Wire, and Nails ... 694
724.03.07 Metal Gates ... 694

MATERIALS DETAILS—*Continued*

SECTION 725—ELASTOMERIC BEARING PADS

Scope PAGE
725.01.01 Materials Covered ... 695
Requirements
725.02.01 Certificate of Inspection ... 695
Physical Properties and Tests
725.03.01 General ... 695
725.03.02 Manufacturing Requirements ... 696
725.03.03 Tolerances ... 697
725.03.04 Quality Assurance ... 697

SECTION 726—ROADSIDE MATERIALS

Scope
726.01.01 Materials Covered ... 699
Requirements
726.02.01 Certificates and Samples ... 699
Physical Properties and Tests
726.03.01 Top Soil ... 700
726.03.02 Fertilizer ... 700
726.03.03 Humus ... 700
726.03.04 Mulch ... 700
726.03.05 Erosion Control Fabric ... 701
726.03.06 Plants ... 701
726.03.07 Seeds ... 701
726.03.08 Tree Ties ... 702
726.03.09 Pipe and Fittings ... 702
726.03.10 Conduit for Future Irrigation Systems ... 702
726.03.11 (Blank)
726.03.12 (Blank)
726.03.13 Masonry ... 703

SECTION 727—CONCRETE SURFACE FINISHING MATERIAL

Scope
727.01.01 Materials Covered ... 705
Physical Properties and Tests
727.02.01 Requirements ... 705

SECTION 728—EPOXY

Scope
728.01.01 Materials Covered ... 707
Requirements
728.02.01 Sampling and Testing ... 707
728.02.02 Certificates ... 707
728.02.03 Packaging, Labeling and Storing ... 707
728.02.04 Directions for Use ... 708

MATERIALS DETAILS—*Continued*

Type of Epoxies PAGE

728.03.01 Binder (Adhesive), Epoxy Resin Base ... 708
728.03.02 (Blank)
728.03.03 Epoxy Resin Adhesive for Bonding New Concrete to Old Concrete ... 708
728.03.04 Rapid Set Epoxy Adhesive for Pavement Markers ... 709
728.03.05 Standard Set Epoxy Adhesive for Pavement Markers ... 709
728.03.06 (Blank)
728.03.07 (Blank)
728.03.08 (Blank)
728.03.09 Epoxy Sealant for Inductive Loops ... 709

SECTION 729—TRAFFIC PAINT

Scope

729.01.01 Material Covered ... 713

Requirements

729.02.01 General ... 713
729.02.02 Packaging ... 713

Physical Properties and Tests

729.03.01 Sampling and Testing ... 714
729.03.02 Materials ... 714

SECTION 730—TRAFFIC BEADS

Scope

730.01.01 General ... 719

Physical Properties and Tests

730.02.01 Requirements ... 719

731—ENGINEERING FABRICS

Scope

731.01.01 Materials Covered ... 721

Requirements

731.02.01 Certificates ... 721

Physical Properties and Tests

731.03.01 Pavement Reinforcing Fabric ... 721

SECTION 732—PERMANENT PAVEMENT MARKING FILM

Scope

732.01.01 Material Covered ... 723

Requirements

732.02.01 Certificates ... 723

Physical Properties and Tests

732.03.01 Permanent Pavement Marking Film ... 723

DIVISION I

GENERAL REQUIREMENTS

SECTION 101

DEFINITIONS AND TERMS

Wherever in these specifications or in other contract documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

101.01 Abbreviations. Wherever the following abbreviations are used in these specifications or on the plans, they are to be construed the same as the respective expressions represented:

AAN—American Association of Nurserymen
AAR—Association of American Railroads
AASHTO—American Association of State Highway and Transportation Officials
ACI—American Concrete Institute
AGC—Associated General Contractors of America
AIA—American Institute of Architects
AISC—American Institute of Steel Construction
AISI—American Iron and Steel Institute
ANSI—American National Standards Institute
ARA—American Railway Association
AREA—American Railway Engineering Association
ASA—American Standards Association
ASCE—American Society of Civil Engineers
ASLA—American Society of Landscape Architects
ASME—American Society of Mechanical Engineers
ASTM—American Society for Testing and Materials
AWG—American Wire Gauge
AWPA—American Wood Preservers Association
AWS—American Welding Society
AWWA—American Water Works Association
Code—National Electric
EIA—Electronic Industries Association
FHWA—Federal Highway Administration—Department of Transportation
FSS—Federal Specifications and Standards, General Services Administration
IEEE—Institute of Electrical and Electronics Engineers
MIL—Military Specifications

MUTCD—Manual on Uniform Traffic Control Devices for Streets and Highways. Published by the Federal Highway Administration
NEMA—National Electrical Manufacturers Association
OSHA—Occupational Safety and Health Administration
SAE—Society of Automotive Engineers
UL—Underwriters Laboratories, Incorporated
USASI—United States of America Standards Institute

101.02 Advertisement. The public announcement, as required by law, inviting bids for work to be performed or materials to be furnished.

101.03 Award. The acceptance by the Department of a bid.

101.04 Base Course. The layer or layers of specified or selected material of designed thickness on a subbase or a subgrade to support a surface course.

101.05 Bidder. An individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, submitting a bid for the advertised work.

101.06 Bridge. A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having an opening measured along the center of roadway of more than twenty (20) feet between undercopings of abutments or spring lines of arches or extreme ends of openings for multiple boxes; may include multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening.

Bridge Length. The greater dimension of a structure measured along the center of the roadway between backs of abutment backwalls or between ends of bridge floor.

Bridge Roadway Width. The clear width of structure measured at right angles to the center of the roadway between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.

101.07 Calendar Day. Every day shown on the calendar, beginning and ending at midnight.

101.08 Contract Change Order. A written order to the Contractor, covering changes in the plans, specifications or quantities, within the scope of the contract, and establishing the basis of payment and time adjustments for the work affected by the changes.

101.09 Channel. A natural or artificial water course.

101.10 Contract. The written agreement between the Department and the Contractor setting forth the obligations of the parties thereunder, includ-

ing, but not limited to, the performance of the work, the furnishing of labor and materials, and the basis of payment.

The contract includes the invitation for bids, proposal, contract form and contract bond, standard specifications, supplemental specifications, special provisions, general and detailed plans, notice to proceed, and any change orders and supplemental agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions and basis of payment thereof, all of which constitute one instrument.

101.11 Contract Bond. The approved form of security, executed by the Contractor and his surety or sureties, guaranteeing complete execution of the contract and all supplemental agreements pertaining thereto and the payment of all legal debts pertaining to the construction of the project.

101.12 Contract Item (Pay Item). An item of work specifically described and for which a price, either unit or lump sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials described in the text of a specific item included in the contract or described in the standard specifications, supplemental specifications, or special provisions of the contract. Contract items are numbered so that the first three (3) digits of the item number correspond to the section of the same number. Thus, in Item No. 203 0100, which is the item number for roadway excavation, the number 203 is the section number and corresponds to Section 203 of the standard specifications, supplemental specifications and special provisions.

Each contract item shall be constructed under the specifications contained in the section of the same number, i.e., the number preceding aforementioned last four (4) digits.

101.13 Contractor. The individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, contracting with the Department of Transportation for performance of prescribed work.

101.14 Contract Time. The number of work days or calendar days allowed for completion of the contract, including authorized time extensions.

In case a calendar date of completion is shown in the proposal in lieu of the number of working or calendar days, the contract shall be completed by that date.

101.15 Culvert. Any structure not classified as a bridge which provides an opening under the roadway.

101.16 Department. The party of the first part to a contract which shall be the Department of Transportation as constituted under the laws of the State of Nevada, for the administration of highway work.

101.17 Detour. A temporary route for traffic around a closed portion of road.

101.18 Directors. The directors of the Department of Transportation of the State of Nevada as established by the laws of the State of Nevada, acting directly or through their authorized representatives.

101.19 Divided Highway. A highway with separated roadways for traffic in opposite directions.

101.20 Employee. Any person working on the project mentioned in the contract of which these specifications are a part, and who is under the direction and control of, or receives compensation from, the Contractor or his subcontractor.

101.21 Engineer. The Director of the Department of Transportation of the State of Nevada, acting either directly or through his duly authorized representatives, who is responsible for the engineering supervision of the construction.

101.22 Equipment. All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the work.

101.23 Extra Work. An item of work not provided for in the contract as awarded but found essential to the satisfactory completion of the contract within its intended scope.

101.24 Frontage Road or Frontage Street. A local street or road auxiliary to and located generally on the side of an arterial highway for service to abutting property and adjacent areas and for control of access.

101.25 Highway. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

101.26 Holidays. In the State of Nevada, these occur on:

January 1 (New Year's Day)
Third Monday in February (Washington's Birthday)
Last Monday in May (Memorial Day)
July 4 (Independence Day)
First Monday in September (Labor Day)
October 31 (Nevada Day)
November 11 (Veterans' Day)
Fourth Thursday in November (Thanksgiving Day)
December 25 (Christmas Day)

or on any day that may be appointed by the President of the United States or by the Governor of Nevada for public fast, thanksgiving or as a legal holiday.

If January 1, July 4, October 31, November 11, or December 25 falls upon a Sunday, the Monday following shall be observed as a holiday.

If January 1, July 4, October 31, November 11, or December 25 falls upon a Saturday, the Friday preceding shall be observed as a holiday.

101.27 Inspector. The Engineer's authorized representative assigned to make detailed inspections of contract performance.

101.28 Laboratory. The testing laboratory of the Department or any other testing laboratory which may be designated by the Engineer.

101.29 Major Contract Item. A "major item" shall be construed to be any individual bid item included in the proposal that has a total cost equal to or greater than fifty thousand dollars ($50,000) or five (5) percent of the total contract cost, whichever is the lesser amount. The total contract cost shall be computed on the basis of the proposal quantities and contract unit prices.

101.30 Materials. Any substances specified for use in the construction of the project and its appurtenances.

101.31 Median. That portion of a divided highway separating the travel ways for traffic generally in opposite directions.

101.32 Notice to Contractors. The official notice inviting bids for the proposed work.

101.33 Notice to Proceed. A written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

101.34 Pavement Structure. The combination of base course and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

101.35 Plans. The approved project plans and standard plans, profiles, typical cross sections, working drawings, and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, and details of the work to be performed. All such documents are to be considered as a part of the plans whether or not noted in the special provisions.

In the above definition, these terms are defined as follows:

(a) Standard Plans—The standard plans of the Department of Transportation.

(b) Project Plans—The project plans are specific details and dimensions peculiar to the work and are supplemented by the standard plans insofar as the same may apply.

101.36 Profile Grade. The trace of a vertical plane intersecting the top surface of the proposed structural section as shown on the plans. Profile grade means either elevation or gradient of such trace according to the context.

101.37 Project. The specific section of the highway together with all appurtenances and construction to be performed thereon at the prices quoted.

101.38 Proposal. The offer of a bidder, on the prescribed form, to perform the work and to furnish the labor and materials at the prices quoted.

101.39 Proposal Form. The approved form on which the Department requires bids to be prepared and submitted for the work.

101.40 Proposal Guaranty. The security furnished with a bid to guarantee that the bidder will enter into the contract if his bid is accepted.

101.41 Right of Way. A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to transportation purposes.

101.42 Road. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

101.43 Roadbed. The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

101.44 Roadside. A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

101.45 Roadside Development. Those items necessary to the complete highway which provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the highway.

101.46 Roadway. The portion of a highway within limits of construction.

101.47 Shoulder. The portion of the roadway contiguous with the travelled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

101.48 Sidewalk. That portion of the roadway primarily constructed for the use of pedestrians.

101.49 Special Provisions. Additions and revisions to the standard and supplemental specifications covering conditions peculiar to an individual project.

101.50 Specifications. The directions, provisions, and requirements contained in the standard specifications and supplemental specifications as modified by the special provisions. Whenever the term "these specifications" is used in this book, it means the provisions set forth in this book.

101.51 State. The State of Nevada acting through its authorized representatives.

101.52 Street. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

101.53 Structures. Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, end walls, buildings, sewers, service pipes, underdrains, foundation drains, and other features which may be encountered in the work and not otherwise classed herein.

101.54 Subcontractor. Any individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, to which the Contractor, with the consent of the Department, sublets any part of the contract.

101.55 Subgrade. The top surface of a roadbed upon which the pavement structure and shoulders, including curbs, are constructed.

101.56 Substructure. All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames, together with backwalls, wingwalls, and wing protection railings.

101.57 Superintendent. The Contractor's authorized representative in responsible charge of the work, present on the work at all times during the progress to supervise and direct the construction, to receive and fulfill instructions from the Engineer, and to accept orders for changed and extra work.

101.58 Superstructure. All that part of a structure above the bearings of simple and continuous spans, skewbacks of arches, and top of footings of rigid frames; excluding backwalls, wingwalls, and wing protection railings.

101.59 Supplemental Agreement. A written agreement made and entered into by and between the Contractor and the Department covering work not otherwise provided for, revisions in or amendments to the terms of the contract, or conditions specifically prescribed in the specifications as requiring supplemental agreements. Such supplemental agreements become a part of the contract when approved and properly executed.

101.60 Supplemental Specifications. Additions and revisions to the standard specifications that are adopted subsequent to the issuance of the printed book.

101.61 Surety. The corporation, partnership, or individual, other than the Contractor, executing a bond furnished by the Contractor.

101.62 Surface Course. One or more layers of a pavement structure

designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer is sometimes called "wearing course."

101.63 Traffic Lane. The portion of a traveled way for the movement of a single line of vehicles.

101.64 Traveled Way. That portion of roadway for the movement of vehicles exclusive of shoulders and auxiliary lanes.

101.65 Work. The furnishing of all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the project and the carrying out of the duties and obligations imposed by the contract.

101.66 Working Day. A calendar day on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for the major part of the day (five (5) hours) with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time, exclusive, however, of Saturdays, Sundays, State recognized holidays, and any day that is incumbent upon the Contractor, by means of a labor union, to observe as a holiday. However, if the Contractor elects to work on such days, those days will be considered as a working day.

Attention is directed to subsections 108.04, "Limitation of Operations," and 108.08, "Determination and Extension of Contract Time."

101.67 Working Drawings. Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

101.68. In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is, or is to be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned," it shall be understood as if the expression were followed by the words "by the Engineer" or "to the Engineer."

SECTION 102

BIDDING REQUIREMENTS AND CONDITIONS

102.01 Notice to Contractors. After the date is fixed for the letting of the work, the Department will give notice of such letting to Contractors. The "Notice to Contractors" will contain a description of proposed work, together with information to the bidder regarding access to the proposal forms, plans, and specifications, the amount and nature of proposal guaranty, and the reservation of the right of the Department to reject any or all bids.

102.02 Prequalification of Bidders. All bidders shall be prequalified as required by law. To be qualified, a prospective bidder shall submit, under oath, on the standard form furnished by the Department, a statement of his financial ability and experience in the performance of contracts for public work. A prospective bidder shall attest to the verity of the data submitted by executing the appropriate certificate which is a part of the "Contractor's Statement of Experience and Financial Condition for Prequalification." After verifying the information contained in the statement, the Department shall notify the submitter of the maximum contract amount and class of work upon which he will be eligible to bid.

All data submitted shall be as of a date not more than nine (9) months prior to the date of filing the statement.

In order to remain on the qualified list, a prospective bidder shall submit a new statement prior to the expiration of his current prequalification. A prospective bidder not already qualified shall submit his statement of financial ability and experience at least five (5) full days prior to the date set for the opening of bids in which he is interested in order to have it considered, but qualification shall not be granted until such statement has been verified. Preferably, statements should be submitted at least thirty (30) days prior to bid opening.

Nothing contained in this section shall be construed as depriving the Department of its discretion in the matter of determining the lowest responsible bidder.

On Federal-aid projects, any Contractor otherwise qualified by the State of Nevada to perform such work is not required to be licensed nor to submit application for license in advance of submitting a bid or having such bid considered, provided, however, that such exception does not constitute a waiver of the State's right under its license laws to require a Contractor, determined to be a successful bidder, to be licensed to do business in the State of Nevada in connection with the award of a contract to him.

No bid will be accepted from, or contract awarded to, a Contractor to whom a proposal form has not been issued by the Department of Transportation.

102.03 Contents of Proposal Forms. Upon request, the Department will furnish the prospective bidder with a proposal form. This form will state the location and description of the contemplated construction and will show

the approximate estimate of the various quantities and kinds of work to be performed or materials to be furnished, and will have a schedule of items for which unit bid prices are invited. The proposal form will state the time in which the work must be completed, the amount of the proposal guaranty, and the date, time, and place of the opening of proposals. The form will also include any special provisions or requirements which vary from or are not contained in the standard specifications.

All papers bound with or attached to the proposal form are considered a part thereof and must not be detached or altered when the proposal is submitted.

The plans, specifications, supplemental notices to contractors, and other documents designated in the proposal form will be considered a part of the proposal whether attached or not.

The prospective bidder or interested nonbidder will be required to pay the Department the sum stated in the advertisement and "Notice to Contractors" for each copy of proposal form and each set of plans. The contract documents are nonreturnable and no refund will be made.

Checks in payment for plans and specifications will be made payable to the State of Nevada, Department of Transportation.

102.04 Interpretation of Quantities in the Proposal. The quantities given in the "Notice to Contractors" and in the proposal and contract forms are approximate only, being given as a basis for the comparison of bids, and the Department does not, expressly or by implication, agree that the actual amount of work will correspond therewith, but reserves the right to increase or decrease the amount of any class or portion of the work, or to omit portions of the work, as may be deemed necessary or advisable by the Engineer.

102.05 Examination of Plans, Specifications, Contract Documents and Site of Work. The Department will prepare plans and specifications giving such directions as will enable any competent mechanic or Contractor to carry them out. The bidder is expected to examine carefully the site of the proposed work, the proposal, plans, specifications, supplemental specifications, special provisions, and contract forms before submitting a proposal. The submission of a bid shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the plans, specifications, supplemental specifications, special provisions, and contract documents.

When a pay item is shown on the plans and not in the proposal, and such pay item is not specifically excluded from payment either in these specifications or in the contract documents, the pay item shall then be considered an obvious omission in the proposal and payment will be made according to the provisions of subsection 104.03, "Extra Work."

Whenever the Department has obtained subsurface information concerning possible material sources, said information will be included in Section 106 of the special provisions.

If foundation reports and soil profiles are available, the findings and conclusions presented in said contract documents were prepared in accordance with generally accepted engineering principles and practices. The

information shown on the log of test borings applies only at the location of the borings and at the time of drilling. Subsurface conditions may be expected to differ at other locations or to change at these locations with time.

Information derived from inspection of records of subsurface investigations made by the Department will not in any way relieve the Contractor from fulfilling the terms of the contract.

If a mass diagram has been prepared for a project, it will be available to the bidders with the understanding that the swell or shrinkage factors of the excavated material and the direction and quantities of haul or overhaul as shown on said mass diagram are for the purpose of design only.

102.06 Preparation of Proposal. The bidder shall submit his proposal upon the forms furnished by the Department. The bidder shall specify a unit price in figures and words for each pay item for which a quantity is given, and shall also show the products of the respective unit prices and quantities, written in figures in the column provided for that purpose, and the total amount of the proposal obtained by adding the amount of the several items. All the words and figures shall be in ink or typed. In case of a discrepancy between the prices written in words and those written in figures, the prices written in words shall govern.

When an item in the proposal contains a choice to be made by the bidder, the bidder shall indicate his choice in writing, in accordance with the specifications for that particular item, and thereafter no further choice will be permitted.

The bidder's proposal must be signed with ink by the individual, by one or more members of the partnership, by one or more members or officers of each firm representing a joint venture, or by one or more officers of a corporation, or by an agent of the Contractor, legally qualified and acceptable to the State. If the proposal is made by an individual, his name and post office address must be shown; by a partnership, the name and post office address of each partnership member must be shown; as a joint venture, the name and post office address of each member or officer of the firms represented by the joint venture must be shown; by a corporation, the name of the corporation and the business address of its corporate officials must be shown.

102.07 Irregular Proposals. Proposals will be considered irregular and may be rejected for the following reasons:

(a) If the proposal is on a form other than that furnished by the Department, or if the form is altered or any part thereof is detached.

(b) If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may tend to make the proposal incomplete, indefinite, or ambiguous as to its meaning.

(c) If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.

This does not exclude a bid limiting the maximum gross amount of awards acceptable to any one bidder or at any one bid letting, provided that the selection of any bid awards be made by the Department.

(d) If the unit prices contained in the proposal are obviously unbalanced, either in excess or below the reasonable cost analysis values.

(e) If the proposal does not contain a unit price for each pay item listed except in the case of authorized alternate pay items.

102.08 Proposal Guaranty. No proposal will be considered unless accompanied by a proposal guaranty, in the amount equal to five (5) percent of the Contractor's bid, made unconditionally payable to the State of Nevada, Department of Transportation. The guaranty may be cash, cashier's check, certified check, postal money order, bank money order, express money order, bank draft, or an undertaking executed by a corporate surety company authorized to do business in the State of Nevada or any other guaranty that may be especially approved by the Department. Such proposal guaranty is to be forfeited to the Department should the bidder to whom the contract is awarded fail to enter into the contract within twenty (20) days after the award.

102.09 Delivery of Proposals. Each proposal should be submitted in a special envelope furnished by the Department. The blank spaces on the envelope shall be filled in correctly to clearly indicate its contents. When an envelope other than the special one furnished by the Department is used, it shall be of the same general size and shape and be similarly marked to clearly indicate its contents. When sent by mail, the sealed proposal shall be addressed to the Department at the address and in care of the official in whose office the bids are to be received. All proposals shall be filed prior to the time and at the place specified in the advertisement and "Notice to Contractors." Proposals received after the time for opening of bids will be returned to the bidder unopened.

102.10 Withdrawal or Revision of Proposals. A bidder may withdraw or revise a proposal after it has been deposited with the Department, provided the request for such withdrawal or revision is received by the Department, in writing or by telegram, before the time set for the opening of proposals. The withdrawal of a proposal shall not prejudice the right of the bidder to file a new proposal provided it is received prior to the time set for opening of proposals.

102.11 Public Opening of Proposals. Proposals will be opened and read publicly at the time and place indicated in the advertisement and "Notice to Contractors." Bidders, their authorized agents, and other interested parties are invited to be present.

102.12 Disqualification of Bidders. Any of the following reasons may be considered as sufficient for the disqualification of a bidder and the rejection of his proposal or proposals:

(a) More than one proposal for the same work from an individual, firm, or corporation under the same or different name.

(b) Evidence of collusion among bidders. Participants in such collusion will receive no recognition as bidders for any future work of the Department until any such participants shall have been reinstated as a qualified bidder.

(c) Unsatisfactory performance record as shown by past work for the Department judged from the standpoint of workmanship and progress.

(d) Uncompleted work which in the judgment of the Department might hinder or prevent the prompt completion of additional work if awarded.

(e) Failure to pay or satisfactorily settle all bills due for labor or material on former contracts in force at the time of letting.

(f) Failure to hold a valid license of a class corresponding to the work to be done as required by the State Contractor's License Law. However, it is not required that a Contractor have a Contractor's license in order to bid on Federal-aid projects.

(g) Failure to comply with any qualification regulations of the Department.

102.13 Material Guaranty. The successful bidder may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the work together with samples, which samples may be subject to the tests provided for in these specifications to determine their quality and fitness for the work.

102.14 Combination or Conditional Bids. On certain projects a bidder may submit bids on more work than he desires to have awarded to him. He may indicate the total amount he desires to accept and the Department will determine which of his low bids on these projects, up to the final total indicated, will be accepted. This limitation will only apply to those projects on which the following statement has been included in the proposal and is properly filled in by the Contractor.

"We desire to disqualify all of our bids at this letting which exceed the total of $..... or ..... contracts and hereby authorize the Department to determine which bids shall be disqualified."

"A proposal guaranty, conforming to subsection 102.08, "Proposal Guaranty," in the amount of $..... accompanies the proposal for project number ..... or has been filed with the Department in advance."

.....
Contractor

102.15 Motor Fuel Tax Refund. It is understood and agreed that the price bid by the Contractor for the work to be done under the contract shall include the applicable tax on motor vehicle fuel and special fuel as required by Chapters 365 and 366 of the Nevada Revised Statutes.

It shall be the Contractor's responsibility to determine that subcontractors have reported fuel consumption to the State of Nevada, Department of Motor Vehicles and Public Safety as required by law.

SECTION 103

AWARD AND EXECUTION OF CONTRACT

103.01 Consideration of Proposals. After the proposals are opened and read, they will be compared on the basis of the summation of the products of the approximate quantities shown in the bid schedule by the unit bid prices. The results of such comparisons will be immediately available to the public. In the event of a discrepancy between unit bid prices and extensions, the unit bid prices shall govern.

The right is reserved to reject any or all proposals, to waive technicalities, or to advertise for new proposals, if in the judgment of the awarding authority, the best interests of the Department will be promoted thereby.

The Department's right to reject any and all proposals includes the right to reject all bids if the lowest responsive bid received exceeds the Engineer's estimate by more than seven (7) percent and it is determined that an award of contract would cause excessive inflationary impact. In the event all bids are rejected for this reason, the contract proposal will be modified and may be deferred for readvertising for bids until a more competitive situation exists.

103.02 Award of Contract. In order to meet the requirement prescribed under Section 112 (c) of Title 23, United States Code, relative to the award of contracts, each bidder shall furnish with his proposal a sworn statement executed by or in behalf of the person, firm, association, or corporation submitting the bid. Such sworn statement shall be in the form appended to the special provisions and shall be sworn to before such persons as are authorized by the laws of the State to administer oaths.

The award of the contract, if it be awarded, will be to the lowest responsible bidder whose proposal complies with all the requirements prescribed. The award, if made, will be made within thirty (30) calendar days after the opening of the proposals. The successful bidder will be notified by letter, mailed to the address shown on his proposal, that his proposal has been accepted and that he has been awarded the contract.

The date of the award of the contract shall be the date of the "Notice of Award."

103.03 Cancellation of Award. The Department reserves the right to cancel the award of any contract at any time before the execution of said contract by all parties without any liability against the Department.

Whenever a contract is awarded to an unlicensed Contractor, it shall be with the full understanding that such award shall become null and void should said Contractor fail to become licensed, in accordance with the provisions of NRS Chapter 624 for any reason within the control of said Contractor, within twenty (20) calendar days after award of said contract.

103.04 Return of Proposal Guaranty. All proposal guaranties, except those of the three (3) lowest bidders, will be returned immediately following

the opening and checking of the proposals. The retained proposal guaranty of the unsuccessful of the three (3) lowest bidders will be returned within ten (10) days following the award of the contract and that of the successful bidder will be returned after a satisfactory bond has been furnished and the contract has been executed.

103.05 Requirement of Contract Bond. The successful bidder shall, at the time of the execution of the contract, furnish a surety bond or bonds in a sum equal to the full amount of the contract as a guaranty that he will complete the work in accordance with the terms of the contract. Such bond, or bonds, shall also provide and secure payment for all materials, labor and supplies, trucks and other means of transportation, used in, or upon, or about, or for the performance of the work contracted to be done, and for any work or labor done thereupon or incidental thereto. The bond or bonds shall be on the form provided in the proposal and shall be written by a surety approved by the Insurance Commissioner of the State of Nevada. A power of attorney for an attorney in fact who executes bonds shall be registered with, and approved by, the Insurance Commissioner of the State of Nevada. The power of attorney shall show the limiting amount authorized for issuance of bonds. Written appointment of agent of bonding company in and for the State of Nevada shall also be registered with, and approved by, the Insurance Commissioner.

103.06 Execution and Approval of Contract. The contract shall be signed by the successful bidder and returned, together with the contract bond, within twenty (20) calendar days after the contract has been mailed to the bidder. If the contract is not executed by the Department within thirty (30) calendar days following receipt of the bidder of the signed contract and bond, the bidder shall have the right to withdraw his bid without penalty. No contract shall be considered as effective until it has been fully executed by all the parties thereto.

103.07 Failure to Execute Contract. Failure to execute the contract and file acceptable bonds and/or failure to obtain a valid Contractor's license within twenty (20) calendar days after the contract has been awarded shall be just cause for the annulment of the award and the forfeiture of the proposal guaranty which shall become the property of the Department, not as a penalty, but as liquidation of damages sustained. Award may then be made as provided in subsection 103.02, "Award of Contract," or the work may be readvertised and constructed under contract or otherwise, as the Department may decide.

SECTION 104

SCOPE OF THE WORK

104.01 Intent of the Contract. The intent of the contract is to provide for the construction and completion in every detail of the work described. The Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

104.02 Increased or Decreased Quantities and Change in Character of Work. The Engineer reserves the right to make by written order and without notice to surety, such alterations in the plans or character or quantity of the work which may be considered necessary or desirable from time to time during the progress of the work to complete satisfactorily the proposed construction. Such alterations shall not be considered as a waiver of any conditions of the contract or invalidate any of the provisions thereof.

The right is reserved to increase or decrease any or all of the items in the estimate of approximate quantities as shown in the proposal. The length of the project may be increased or decreased by adding or omitting sections or by relocation. Under no circumstances shall alterations of plans or of the nature of the work involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project.

Whenever the termini of the project are changed, a supplemental agreement acceptable to both parties to the contract shall be executed in advance of performing the affected work.

Bid price adjustments shall be based on the following:

(a) Increases of Major Bid Item Quantities. If it is found that the quantity of any major bid item overruns less than twenty-five (25) percent of the proposal quantity, payment for the work performed will be made at the contract unit price for the quantity of work actually performed.

If it is found that any major bid item of the work overruns more than twenty-five (25) percent of the proposal quantity, either party to the contract may seek a unit price adjustment either upward or downward for those quantities in excess of twenty-five (25) percent of the original proposal quantity. Any such price adjustment will be determined by documented proof of an increase or decrease in actual costs. Documentation shall include a breakdown showing the basis of the Contractor's unit bid price.

Price adjustments will not be allowed for other than major bid items.

(b) Decrease of Major Bid Item Quantities. If it is found that the quantity of any major bid item underruns less than twenty-five (25) percent of the proposal quantity, payment for the work performed will be made at the contract unit price for the quantity of work actually performed.

If it is found that any major bid item of the work underruns more than twenty-five (25) percent of the proposal quantity, the Contractor may seek a unit price adjustment upward. Any such price adjustment will be determined by documented proof of an increase in actual costs. Documentation shall

include a breakdown showing the basis of the Contractor's unit bid price. In no event, however, shall the total payment exceed that which would be made for seventy-five (75) percent of the proposal quantity at the contract unit price.

Price adjustments will not be allowed for other than major bid items.

(c) Change in Character of the Work. If an ordered change in the plans or specifications materially changes the character of the work of a contract item from that on which the Contractor based his bid price, the Contractor may request an adjustment of the unit bid price. Revision of any unit price shall be negotiated on the basis of actual costs plus a reasonable allowance for profit and overhead.

The work shall be performed in accordance with the specifications and as directed, provided, however, that before such work is started a contract change order acceptable to both parties to the contract shall be executed.

If a change order satisfactory to both parties cannot be agreed upon, the Engineer may order the work in dispute to be performed on a force account basis or he may cancel the work from the contract.

Failure by the Contractor to notify the Engineer in writing of a change in character of work and his subsequent performance of said work shall be considered as a waiver thereof on the part of the Contractor and payment shall be made at the contract unit price for the actual quantity of the work performed.

104.03 Extra Work. The Contractor shall perform unforeseen work, for which there is no price included in the contract, whenever it is deemed necessary or desirable in order to complete fully the work as contemplated. Such work shall be performed in accordance with the specifications and as directed, and will be paid for as agreed unit prices, force account, or a combination of the two. Agreed unit prices together with the estimated quantities of each unit shall be shown. Orders involving extra and force account work shall be as detailed in subsection 109.03, "Extra and Force Account Work," and conform to the requirements contained therein.

104.04 Maintenance of Traffic. While undergoing improvements, the road shall be kept open to all traffic by the Contractor unless otherwise provided for in the contract documents. If the usable roadway is not sufficient to safely accommodate two-way traffic, the Contractor shall adequately maintain one-way traffic. Wherever one-way traffic is in effect, the distance shall not be in excess of six thousand (6,000) feet or as otherwise set forth in writing by the Engineer. Where controlled traffic is necessary for protection of the work or for the safety of public travel, it shall be in accordance with the provisions of Section 624, "Accommodations for Public Traffic," of these specifications. The Contractor shall also provide and maintain in a safe condition, temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages, and farms. Snow removal, however, will not be required of the Contractor. The Contractor shall bear all expense of maintaining the roadway over the section of road undergoing improvement and of constructing and maintaining such

approaches, crossings, intersections, and other features as may be necessary, without direct compensation, except as provided in subsection 107.15, "Relief from Maintenance and Responsibility," or in (a) or (b) below:

(a) Detours and Maintain Base. When required, detours shall be constructed, maintained, and removed as indicated in the contract documents or as directed by the Engineer and such work shall be measured and paid for as specified in Section 624, "Accommodations for Public Traffic."

When the proposal contains an item for "Maintain Base," the Contractor will be paid on a "force account" basis for maintenance of the roadway base. Attention is directed to Section 624, "Accommodations for Public Traffic."

(b) Maintenance of Traffic During Suspension of Work. The Contractor shall be responsible for the maintenance of the roadway during suspension of the work when such suspensions are due to the Contractor's negligence. Attention is directed to subsection 108.06, "Temporary Suspension of the Work." During any other suspension, the Contractor shall make passable and shall open to traffic such portions of the project and temporary roadways or portions thereof as may be agreed upon between the Contractor and the Engineer for the temporary accommodation of traffic during the anticipated period of suspension. Thereafter, and until an issuance of an order for the resumption of construction operations, the maintenance of the temporary route or line of travel agreed upon will be by and at the expense of the Department. Such maintenance and responsibility will include and be restricted to: the travelled roadway for the convenience of public travel; opening plugged pipes and roadway ditches and drains or correcting any other hazard which may be detrimental to adjacent property owners or the travelling public. When work is resumed, it shall be the Contractor's responsibility to replace, renew, and repair any work or materials lost or damaged because of such temporary use of the project regardless of the cause of such damage or loss, except as provided in subsection 107.15, "Relief of Maintenance and Responsibility." It is herewith expressed that the Department is in no way responsible to the Contractor to maintain the roadway and appurtenances in any certain condition or state of repair. It is incumbent upon the Contractor to complete the project in every respect as though its prosecution had been continuous and without interference.

Where construction of a project is staged in the plans, or otherwise outlined by the contract documents, and if a change in the staging or sequence of operations is desirable, the Contractor may submit such change in writing to the Engineer. Consideration will be given to each such proposal and may be rejected, modified or accepted by the Engineer as he deems best. The Contractor will not proceed with any such change in the staging until permission is granted by the Engineer in writing.

When detours, temporary connections, crossovers, connection roads, and frontage roads are constructed by the item "equipment hours," such item shall be full compensation for excavating, hauling, overhaul, and compacting of the material complete and in place and for all labor involved to complete the detour. Base and surface courses will be paid for at the contract unit price for the particular type of material required. All of the above-mentioned roadways will be constructed to the same standards and qualities and subject to the same

tests and specifications as the main roadway. Attention is directed to Section 624, "Accommodations for Public Traffic."

When a detour is requested by the Contractor he shall make a written request to the Engineer for the establishment of a detour around all or certain designated sections of work. If arrangements for such a detour can be made which are satisfactory to the State, to the Contractor, and to the governmental agency having jurisdiction over the road to be used, the Engineer will designate that road as a detour, subject to the following conditions:

(a) The Contractor shall provide and maintain the necessary route marking signs.

(b) The Contractor shall construct and maintain in good condition such a detour. If the Contractor fails to maintain the detour in such a condition satisfactory to the Engineer, the State will make such repairs as is deemed suitable and will deduct the cost thereof from money due or to become due to the Contractor.

(c) Provisions for handling traffic will be subject to the conditions of Section 624, "Accommodations for Public Traffic," of these specifications.

(d) Upon abandoning the detour, the Contractor shall obliterate and dispose of such detour and restore as nearly as possible the condition of the ground to its original form and to the satisfaction of the Engineer.

(e) All of the above work will be at the sole expense of the Contractor.

104.05 Rights in and Use of Materials Found on the Work. The Contractor, with the approval of the Engineer, may use on the project such stone, gravel, sand, or other material determined suitable by the Engineer, as may be found in the excavation and will be paid for both the excavation of such materials at the corresponding contract unit price and also at the contract unit price for the pay item for which the excavated material is used. He shall replace at his own expense with other acceptable material all of that portion of the excavation material so removed and used which was needed for use in the embankments, backfills, approaches, or otherwise. No charge for the materials so used will be made against the Contractor. The Contractor shall not excavate or remove any material from within the highway location which is not within the grading limits, as indicated by the slope and grade lines, without written authorization from the Engineer.

Unless otherwise provided, the material from any existing old structure may be used temporarily by the Contractor in the erection of the new structure. Such material shall not be cut or otherwise damaged except with the approval of the Engineer.

104.06 Final Clean Up. Before final acceptance, the Contractor shall remove or obliterate, insofar as feasible, all objects or disturbances of the ground which mar the landscape and were caused by his operations, whether or not part of the improvement. This shall be required on all areas used or occupied by the Contractor within or outside the right of way limits.

Rubbish, excess material, temporary structures, and discarded equipment shall be collected and buried or otherwise disposed of as directed by the Engineer. Pits or trenches for equipment set-ups or camp sites shall be filled

and the ground restored, insofar as feasible, to its original conditions, within or outside of the right of way limits. Temporary haul roads within the right of way limits shall be scarified and bladed to blend with surroundings. Pits from which materials have been obtained shall be dressed and shaped to conform with the surrounding ground. Waste shall be removed from the tops of banks and placed in the bottom of pit. Unless otherwise specified or directed by the Engineer, banks of pits shall be cut to not steeper than three to one (3:1) slopes to blend with the natural contours. Bottoms of pits shall be reasonably smooth. All other disturbances shall be removed or corrected as directed by the Engineer. Burning of material will not be permitted. The Contractor's attention is directed to Section 201, "Clearing and Grubbing," of these specifications.

SECTION 105

CONTROL OF WORK

105.01 Authority of the Engineer. The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; all questions which may arise as to the interpretation of the plans and specifications; all questions as to the acceptable fulfillment of the contract on the part of the Contractor.

The Engineer will have the authority to suspend the work wholly or in part due to the failure of the Contractor to correct conditions unsafe for the workmen or the general public; for failure to carry out the provisions of the contract; for failure to carry out orders; for such periods as he may deem necessary due to unsuitable weather; for conditions considered unsuitable for the prosecution of the work; or for any other condition or reason deemed to be in the public interest.

Whenever the Contractor fails to carry out orders of the Engineer, the Engineer will have executive authority to enforce such orders and his decision will be final. In the event the Contractor fails to execute work ordered by the Engineer within a reasonable period of time, the Engineer may, after giving notice in writing to the Contractor, proceed to have such work performed as deemed necessary and the cost thereof shall be deducted from compensation due or which may become due the Contractor on the contract.

Decisions of the Engineer shall be subject to appeal to the Board of Directors, whose decisions shall be final and conclusive. Such appeal shall be in writing and shall be made within ten (10) calendar days, but in the meantime the Contractor shall diligently proceed with the work.

105.02 Plans and Working Drawings. Plans will show details of all structures, lines, grades, typical cross sections of the roadway, location and design of all structures, and a summary of items appearing on the proposal. The Contractor will keep one set of plans available on the work at all times.

The plans will be supplemented by such working drawings as are necessary to adequately control the work. Working drawings for structures shall be furnished by the Contractor. They shall include stress sheets, shop drawings, erection plans, fabrication sheets, falsework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data required by the Engineer. Unless otherwise specified, all working drawings must be submitted in triplicate ten (10) days prior to start of related work and approved by the Engineer. Such approval shall not operate to relieve the Contractor of any of his responsibility under the contract for the successful completion of the work. It is mutually agreed that the Contractor shall be responsible for agreement of dimensions and details as well as for conformity of his working drawings with the approved plans and specifications.

The contract price will include the cost of furnishing all working drawings.

105.03 Conformity With Plans and Specifications. All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions, and materials requirements, including tolerances, shown on the plans or indicated in the specifications.

In the event the Engineer finds the materials or the finished product in which the materials are used not within reasonably close conformity with the plans and specifications but that reasonably acceptable work has been produced, he shall then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials as he deems necessary to conform to his determination based on engineering judgment.

In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in reasonably close conformity with the plans and specifications and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

105.04 Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions. The specifications, supplemental specifications, plans, special provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scale dimensions; plans will govern over specifications; supplemental specifications will govern over specifications; special provisions will govern over both specifications and plans.

The Contractor shall take no advantage of any apparent error or omission in the plans or specifications. In the event the Contractor discovers such an error or omission, he shall immediately notify the Engineer. The Engineer will then make such corrections and interpretations as may be deemed necessary for fulfilling the intent of the plans and specifications.

105.05 Cooperation by Contractor. The Contractor will be supplied with a minimum of four (4) sets of approved plans and contract assemblies including special provisions, one set of which the Contractor shall keep available on the work at all times. Additional copies of plans and special provisions may be obtained by the Contractor upon written request to the Department.

The Contractor shall give the work constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer, his inspectors, and other contractors in every way possible.

The Contractor shall have on the work at all times, as his agent, a competent superintendent capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer or his authorized representatives. Such superintendent shall be designated in writing

before starting work. The superintendent shall have full authority to execute orders or directions of the Engineer without delay, and to promptly supply such materials, equipment, tools, labor, and incidentals as may be required. Such superintendence shall be furnished irrespective of the amount of work sublet.

Whenever the Contractor or his authorized representative is not present on any particular part of the work where it may be desired to give direction, orders will be given by the Engineer to the Contractor's superintendent, foreman, or other person in charge of the operation, who is present, and these orders shall have the same force and effect as if given to the Contractor or his designated representative.

Any order given by the Engineer, not otherwise required by the specifications to be in writing, will on request of the Contractor be given or confirmed by the Engineer in writing.

105.06 Cooperation with Utilities. The Department will notify all utility companies, all pipeline owners, or other parties affected, and endeavor to have all necessary adjustments of the public or private utility fixtures, pipelines, and other appurtenances within or adjacent to the limits of construction, made as soon as practicable.

Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cable ways, signals, and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted are to be moved by the owners at their expense, except as otherwise provided for in the special provisions or as noted on the plans.

Attention is directed to the possible existence of underground facilities not known to the State or in a location different from that which is shown on the plans or in the special provisions. The Contractor shall take steps to ascertain the exact location of all underground facilities prior to doing work that may damage such facilities or interfere with their service.

Where it is determined by the Engineer that the rearrangement of an underground facility, the existence of which is not shown on the plans or in the special provisions, is essential in order to accommodate the highway improvement, the Engineer will provide for the rearrangement of such facility by other forces or such rearrangement shall be performed by the Contractor and will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Any delays to the Contractor's operations as a direct result of utility or other nonhighway facilities not being rearranged as herein provided (other than delays in connection with rearrangements made to facilitate his construction operations) will be considered right of way delays within the meaning of subsection 108.12, "Right of Way Delays."

Compensation for such delay will be determined in accordance with subsection 108.12, "Right of Way Delays," and no further compensation will be allowed therefor. Attention is directed to subsection 107.17, "Contractor's Responsibility for Utility Property and Service."

105.07 Cooperation Between Contractors. The Department reserves the right at any time to contract for and perform other or additional work on or near the work covered by the contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other as directed.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with his contract and shall protect and save harmless the Department from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by him because of the presence and operations of other Contractors working within the limits of the same project.

The Contractor shall arrange his work and shall place and dispose of the materials being used so as not to interfere with the operations of other Contractors within the limits of the same project. He shall join his work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

105.08 Construction Stakes, Lines, and Grades. The Engineer will set construction stakes establishing lines, slopes, and continuous profile-grade in road work, and centerline and bench marks for bridge work, culvert work, protective and accessory structures, and appurtenances as he may deem necessary, and will furnish the Contractor with all necessary information relating to lines, slopes, and grades. These stakes and marks shall constitute the field control by and in accordance with which the Contractor shall establish other necessary controls and perform the work.

The Contractor shall be held responsible for the preservation of all stakes and marks, and if any of the construction stakes or marks have been carelessly or willfully destroyed or disturbed by the Contractor, the cost of replacing them will be charged against him and will be deducted from the payment for the work.

The Department will be responsible for the accuracy of line, slopes, grades, and other engineering work which is set forth under this section. Attention is directed to subsection 108.04, "Limitation of Operations."

105.09 Authority and Duties of the Resident Engineer. As the direct representative of the Director of the Department of Transportation, the Resident Engineer has immediate charge of the engineering details of each construction project. He is responsible for the administration and satisfactory completion of the project. The Resident Engineer shall have the authority to reject defective materials and to suspend any work that is being improperly performed.

105.10 Duties of the Inspector. Inspectors employed by the Department will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The inspector will not be authorized to alter or waive the provisions of the contract. The inspector

will not be authorized to issue instructions contrary to the plans and specifications, or to act as foreman for the Contractor; however, he shall have the authority to reject work or materials until any questions at issue can be referred to and decided by the Engineer.

105.11 Inspection. All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Engineer shall be provided acceptable access to all parts of the work and shall be furnished with such information and assistance by the Contractor as required to make a complete and detailed inspection.

If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing and the replacing of the covering, or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing and replacing of the covering, or making good of the parts removed will be at the Contractor's expense.

Any work done or materials used without inspection by an authorized Department representative may be ordered removed and replaced at the Contractor's expense unless the Department representative failed to inspect after having been given reasonable notice in writing that the work was to be performed.

When facilities of any unit of government or political subdivision or of any railroad corporation or public utility corporation are adjusted or constructed as a part of the work covered by this contract, its respective representatives shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political subdivision or any railroad corporation or public utility corporation a party to this contract, and shall in no way interfere with the rights of either party thereunder.

105.12 Removal of Unacceptable and Unauthorized Work. All work which does not conform to the requirements of the contract will be considered as unacceptable work, unless otherwise determined acceptable under the provisions in subsection 105.03, "Conformity With Plans and Specifications."

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause, found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner.

Work done contrary to the instructions of the Engineer, work done beyond the lines shown on the plans, or as given, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

Upon failure on the part of the Contractor to comply forthwith with any order of the Engineer, made under the provisions of this article, the Engineer will have authority to cause unacceptable work to be remedied or removed

and replaced and unauthorized work to be removed and to withhold the costs from any money due or to become due the Contractor.

105.13 Load and Speed Restrictions. The Contractor shall be responsible for all damage to the work caused by his hauling equipment.

In hauling material for incorporation in portions of highways under construction or reconstruction, hereinafter called the project, loads which are in excess of the limits set by the Department will not be permitted on any new or existing bridge or new and existing bituminous base and surface, cement treated base, or Portland cement concrete paving which is to remain in place for vehicular traffic within the project or between the project and the material deposits or other sources of materials. Load limits established by the Department for the project shall be complied with regardless of the source of materials, whether from designated or nondesignated deposits or approved commercial sources. Unless otherwise stated in the special provisions or permitted in writing by the Engineer, the maximum loads shall not exceed the limits set forth in Chapter 484 of the Nevada Revised Statutes and all acts amendatory thereto or supplementary thereof.

The Engineer may, for the protection of the travelling public, establish speed limits on or adjacent to the project. Such limitations of speed shall be strictly observed by the Contractor.

105.14 Maintenance During Construction. The Contractor shall maintain the work during construction and until the project is accepted, except as provided for in subsections 104.04, "Maintenance of Traffic," and 107.15, "Relief from Maintenance and Responsibility." This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces to the end that the roadway and structures are at all times to be kept in a condition satisfactory to the Engineer.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

Except as provided for in subsections 104.04, "Maintenance of Traffic," and 107.15, "Relief from Maintenance and Responsibility," all costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various pay items and the Contractor will not be paid an additional amount for such work.

105.15 Failure to Maintain Roadway or Structure. If the Contractor, at any time, fails to comply with the provisions of subsection 105.14, "Maintenance During Construction," the Engineer will immediately notify the Contractor in writing of such noncompliance. If the Contractor fails to remedy unsatisfactory maintenance within twenty-four (24) hours after receipt of such notice, the Engineer may immediately proceed to maintain the project, and the entire cost of this maintenance will be deducted from money due or to become due the Contractor.

105.16 Final Acceptance. Upon due notice from the Contractor or

presumptive completion of the entire project, the Engineer will make an inspection and if all construction and final cleanup provided for and contemplated by the contract is found completed to his satisfaction, that inspection shall constitute the final inspection. Attention is directed to subsection 104.06, "Final Cleanup," of these specifications.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the Engineer will give the Contractor the necessary instructions for correction of same, and the Contractor shall immediately comply with and execute such instructions. Upon correction of the work another inspection will be made which shall constitute the final inspection provided the work has been satisfactorily completed. In such event the Engineer will notify the Contractor in writing and the Department will assume maintenance responsibilities for the project as of the date of final inspection.

After final inspection has been established as provided above, the Engineer shall cause the publication of a notice of the date of final acceptance of the contract.

105.17 Claims for Adjustment and Disputes. If, in any case, the Contractor deems that additional compensation is due him for work or material not clearly covered in the contract or not ordered by the Engineer as extra work as defined herein, the Contractor shall notify the Engineer in writing of his intention to make claim for such additional compensation before he begins the work on which he bases the claim. If such notification is not given, and the Engineer is not afforded proper facilities by the Contractor for keeping strict account of actual cost as required, then the Contractor hereby agrees to waive any claim for such additional compensation. Such notice by the Contractor, and the fact that the Engineer has kept account of the cost as aforesaid, shall not in any way be construed as proving or substantiating the validity of the claim. If the claim, after consideration by the Engineer, is found to be just, it will be paid as extra work as provided herein for "force account" work. Nothing in this subsection shall be construed as establishing any claim contrary to the terms of subsection 104.02, "Increased or Decreased Quantities and Change in Character of Work."

105.18 Value Engineering Proposals. The Contractor may submit to the Engineer, in writing, Value Engineering Proposals (VEP) for modifying the plans, specifications, or other requirements of the contract for the purpose of reducing the total cost of construction without reducing design capacity or quality of the finished product. If accepted by the Department, net savings resulting from a VEP will be shared by the Department and the Contractor on a fifty-fifty (50–50) basis.

The requirements herein apply to all VEPs initiated and developed by the Contractor and which are identified as such by the Contractor at the time of its submission to the Engineer; however, nothing herein shall be construed as requiring the Engineer to consider or approve a VEP submitted hereunder.

Each VEP shall result in a net savings over the contract costs without impairing essential functions and characteristics of the item(s) or of any other part of the project, including but not limited to environmental considerations,

service life, reliability, economy of operation, ease of maintenance, desired aesthetics, and safety.

As a minimum, the following information shall be submitted with each VEP:

(a) A statement that the proposal is submitted as a VEP;

(b) A statement concerning the basis for the VEP and benefits to the Department together with an itemization of the contract requirements affected by the VEP;

(c) A detailed estimate of the cost under the existing contract and under the VEP;

(d) Proposed specifications and recommendations as to how such VEP changes are to be accomplished; and

(e) A statement as to the time by which a contract change order adopting the VEP must be issued so as to obtain the maximum cost effectiveness.

The Department will process the VEP in the same manner as prescribed for any other proposal which would necessitate issuance of a contract change order. The Department may accept in whole or in part any VEP by issuing a contract change order which will identify the VEP on which it is based. The Department will not be liable to the Contractor for failure to accept or act upon any VEP submitted pursuant to these requirements nor for any delays to the work attributable to any such proposal. Until a proposal is effected by contract change order, the Contractor shall remain obligated to perform under the terms and conditions of the existing contract. If an executed contract change order has not been issued by the date upon which the Contractor's proposal specifies that a decision thereon should be made, or such other date as the Contractor may have subsequently specified in writing, such proposal shall be deemed rejected.

The contract change order effecting the necessary contract modification will establish the net savings agreed upon, will provide for adjustment in the contract prices and will indicate the new savings to be equally divided between the Contractor and the Department. The Contractor shall absorb all costs incurred in preparing a VEP for submission to the Department. All reasonably incurred costs of reviewing and administering the VEP will be borne by the Department. The Department reserves the right to include in the agreement any conditions it deems appropriate for consideration, approval, and implementation of the proposal. The Contractor's fifty (50) percent share of the net savings shall constitute full compensation to him for effecting all changes pursuant to the agreement.

Acceptance of the VEP and performance of the work thereunder will not change the contract time limit as a result of the VEP, unless specifically provided for in the contract change order authorizing the VEP.

The Department expressly reserves the right to adopt a VEP for general use in contracts administered by the Department when it determines that said proposal is suitable for application to other contracts. VEPs identical or similar to previously submitted proposals will be eligible for consideration and compensation under these provisions if such proposals were not previously adopted for general application to other contracts administered by the Department. When a VEP is adopted for general use, compensation pursuant

to these requirements will be applied only to those contracts awarded and for which the subject VEP has been submitted prior to the date of adoption of the specific VEP.

Proposed changes in the basic design of a bridge or pavement type, or which require different right of way limits, will not normally be considered as an acceptable VEP. If a VEP is based upon or similar to a change in the plans, specifications, or special provisions adopted by the Department prior to submission of VEP, the Engineer will not accept such proposal.

The Engineer shall be sole judge of the acceptability of a VEP.

Subject to the provisions contained herein, the Department or any other public agency shall have the right to use all or part of any accepted VEP without obligation or compensation of any kind to the Contractor.

In the event a VEP is accepted by the Department, the provisions of subsection 104.02, "Increased or Decreased Quantities and Change in Character of Work," of these specifications which pertain to adjustment of contract unit prices due to alterations of contract quantities will not apply to items adjusted or deleted as a result of effecting the VEP by contract change order.

SECTION 106

CONTROL OF MATERIAL

106.01 Source of Supply and Quality Requirements. The Contractor shall furnish all materials required to complete the work, except materials that are designated in the special provisions to be furnished by the State as specified in subsection 106.11, "Department Furnished Materials."

Only materials conforming to the requirements of the specifications shall be incorporated in the work.

The materials furnished and used shall be new, except as may be provided elsewhere in these specifications, on the plans or in the special provisions. The materials shall be manufactured, handled and used in a workmanlike manner to ensure completed work in accordance with the plans and specifications.

The Contractor shall notify the Engineer of his proposed source(s) of material sufficiently in advance of their use to enable the Engineer to properly inspect and test said sources of material.

If it is found after trial that sources of supply for previously approved materials do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, the Contractor shall furnish satisfactory materials from other sources.

The Contractor shall furnish without charge such samples as may be required. Inspections and tests will be made by the Engineer or his designated representative, but it is understood that such inspections and tests, if made at any point other than the point of incorporation in the work, in no way shall be considered as a guarantee of acceptance of such material nor of continued acceptance of material presumed to be similar to that upon which inspections and tests have been made.

Manufacturer's warranties, guarantees, instruction sheets, and parts lists, which are furnished with certain articies or materials incorporated in the work, shall be delivered to the Engineer before acceptance of the contract.

Reports and records of inspections made and tests performed when available at the site of the work may be examined by the Contractor.

106.02 Local Materials. Local material is rock, sand, gravel, earth, or other mineral material, including borrow, selected borrow, or other selected material, obtained or produced from sources in the vicinity of the work specifically for use on the project. Local material does not include materials obtained from established commercial sources.

Local materials shall be furnished by the Contractor from any source the Contractor may elect, except when a mandatory source is designated in the special provisions.

Aggregates for base, surface, and concrete may be the products of approved commercial producers, provided they meet specification requirements.

The furnishing of local materials from any source (except established commercial sources) is subject to the provisions of subsections 102.05,

"Examination of Plans, Specifications, Contract Documents, and Site of Work," and 106.03, "Possible Local Material Sources." Material deposits shall not be excavated where their resulting scars will present an unsightly appearance from any highway, unless such deposit is approved in writing by the Engineer.

The Contractor's pit operations shall not encroach within twenty-five (25) feet of highway right of way. Payment will not be made on material obtained in violation of this provision.

The following requirements shall apply to all material sites used on the project regardless of whether such material sites are located on private lands or public lands, with the exception of stone quarries and previously excavated areas and established commercial sources, as follows:

(a) Prior to removing any material for construction purposes, the Contractor shall strip and stockpile the top six (6) inches of material in such a manner that it may later be used to cover the excavated area as directed in subparagraph (c) below.

(b) Prior to completion of the project, the banks of the entire excavated area shall be sloped to a ratio of not less than three to one (3:1) and the bottom or floor of the excavated area shall be graded to present a neat and uniform appearance.

(c) All waste (except for brush removed from the deposit area) resulting from the Contractor's operations in the deposit area shall be placed on the floor of the deposit area and shaped to blend therewith. After all waste material has been placed on the floor of the pit and the sides and bottom of the excavated area have been shaped as specified, the material excavated and stockpiled as required in subparagraph (a) shall be uniformly distributed over the entire excavated area in such a manner that the area will present a neat and uniform appearance satisfactory to the Engineer. Brush removed from the deposit area shall be mulched and mixed with the top six (6) inches of material as it is spread over the deposit area or said brush shall be otherwise disposed of in a manner satisfactory to the Engineer. Burning of brush shall not be permitted.

(d) The requirements outlined above pertaining to removing, stockpiling, and relaying the top six (6) inches of material shall apply to areas first excavated on the project and not to areas previously excavated where all topsoil has been removed.

(e) All work required herein shall be accomplished by the Contractor prior to completion of the project.

The cost of stripping the top six (6) inches of material, handling, stockpiling, and spreading the stripped material, overburden and other waste, mulching and/or otherwise disposing of brush as well as the cost of shaping the excavated area and haul roads to deposit areas will not be paid for directly but shall be considered as included in the contract prices bid for other items of work.

In addition to such other approval as may be required by these specifications, acceptance of material from deposits obtained by the Contractor located upon privately owned lands shall also be contingent upon a written agreement being entered into between the Contractor and landowner, which terms shall

include the landowner's consent to the performance, by the Contractor, of the work and operations required by the above subparagraphs (a) through (e), inclusive. The terms of the agreement shall also include the landowner's consent to permit the State of Nevada, Department of Transportation, or its designee, to enter the land at a later date for the purposes of fertilizing and seeding the deposit area and haul roads thereto. Prior to performing any work in connection with a privately owned deposit, the Contractor shall furnish three (3) certified copies of said agreement to the Engineer and further, prior to acceptance of the project, the Contractor shall submit written evidence that the terms of such agreement have been complied with.

The Contractor shall, at his own expense, make any and all arrangements necessary for hauling over local, public, or private roads or property from any source. Full compensation for furnishing all labor, materials, tools, equipment, and incidentals, for doing all the work involved in conforming to the provisions in this subsection and for furnishing and producing materials from any source shall be considered as included in the price paid for the contract item of work involving such material and no additional compensation will be allowed therefor.

106.03 Possible Local Material Sources. If the Contractor desires to use materials from sources other than those described in subsection 106.02, "Local Materials," of the special provisions, he shall, at his own expense, acquire the necessary right to take material and shall obtain all other necessary permits and approvals and shall comply with all the requirements and stipulations in effect by other governing agencies having jurisdiction over the area, and pay all costs involved, including any which may result from an increase in length of haul. All costs of exploring and developing such alternate sources shall be borne by the Contractor and the use of material from such sources will not be permitted until representative samples taken by the Engineer have been approved and written authority issued for the use thereof.

Should such alternate source be located on U.S. Government owned land the Contractor shall be responsible for making application to the Bureau of Land Management or other responsible agency for the right to remove materials therefrom and shall submit the required request for exploration permit, mining plan, and/or other documents required by the agency involved.

If the successful bidder so requests, in writing, the exception to the above shall be that the Department will apply for a free use permit on those deposits located on U.S. Government lands subject to the following conditions:

(a) No such request shall be considered prior to award of the contract.

(b) No such request shall be considered unless it is accompanied by a written proposal which must show a substantial benefit to the public. The Department reserves the right to reject any proposal.

(c) Approval or rejection of any proposal shall not be considered sufficient cause for any adjustment of the contract time allowed to complete the contract.

(d) If the successful bidder's proposal (with mutually agreed revisions, if any) is accepted, the Department will execute a contract change order setting

forth the terms and conditions regarding the application for a free use permit for said deposit(s). Once the contract change order has been fully executed by both parties to the contract, the Department will proceed with the application for a free use permit.

In the event approval of a free use permit results in a net cost savings, the Contractor shall receive fifty (50) percent and the Department fifty (50) percent.

(e) It is mutually understood and agreed by both parties to the contract that the Department cannot guarantee success in obtaining free use permits and in the event of failure to do so, it is further agreed that both parties to the contract are released and held harmless from the terms and conditions of any contract change order which was executed in accordance with subparagraph (d) above.

If the Contractor elects to use an alternate source as provided in these specifications, and such alternate source is located on privately owned lands, approval of such alternate source shall be subject to the following additional requirements and said additional requirements shall be satisfied before any work, including exploration and sampling, will be permitted. The additional requirements are as follows:

(a) The Department, at its sole expense, will conduct visual analysis and erosion control studies of the proposed site.

(b) Once the Department has approved the proposed site regarding visual analysis and erosion control, the Contractor, at his sole expense, shall cause archeological and historic studies of the site and haul roads thereto to be made and such studies shall be submitted to the Engineer for approval. Written approval of said studies shall constitute approval of the site as an alternate source provided all other applicable requirements of these specifications are complied with.

The Contractor's attention is especially directed to the new Part 23 of Title 43, Code of Federal Regulations, titled "Surface Exploration, Mining and Reclamation of Lands," which pertains to all exploration, developing, and obtaining material from said alternate deposits located upon land under the jurisdiction of the Bureau of Land Management. A pertinent portion of this Part 23 follows:

§ 23.8 Approval of mining plan.

(a) (1) Before surface mining operations may commence under any permit or lease issued under the mineral leasing acts the operator must file a mining plan with the mining supervisor and obtain his approval of the plan. Paragraphs (b) through (g) of this section confer authority upon mining supervisors with respect to mining plans pertaining to permits or leases issued under the mineral leasing acts. The mining supervisor shall consult with the district manager with respect to the surface protection and reclamation aspects before approving said plan.

(2) Before surface mining operations may commence under any permit issued or contract made under the Materials Act, the operator must file a mining plan with the district manager and obtain his approval of the plan. Paragraphs (b) through (g) of this section confer authority

upon district managers with respect to mining plans pertaining to permits issued or contracts made under the Materials Act.

(b) Depending on the size and nature of the operation and the requirements established pursuant to § 23.5, the mining supervisor or the district manager may require that the mining plan submitted by the operator include any or all of the following:

(1) A description of the location and area to be affected by the operations;

(2) Two copies of a suitable map, or aerial photograph showing the topography, the area covered by the permit, lease, or contract, the name and location of major topographic and cultural features, and the drainage plan away from the area to be affected;

(3) A statement of proposed methods of operating, including a description of proposed roads or vehicular trails; the size and location of structures and facilities to be built;

(4) An estimate of the quantity of water to be used and pollutants that are expected to enter any receiving waters;

(5) A design for the necessary impoundment, treatment or control of all runoff water and drainage from workings so as to reduce soil erosion and sedimentation and to prevent the pollution of receiving waters;

(6) A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, damage to fish and wildlife, and hazards to public health and safety; and

(7) A statement of the proposed manner and time of performance of work to reclaim areas disturbed by the holder's operations.

(c) In those instances in which the permit, lease, or contract requires the revegetation of an area of land to be affected the mining plan shall show:

(1) Proposed methods of preparation and fertilizing the soil prior to replanting;

(2) Types and mixtures of shrubs, trees, or tree seedlings, grasses or legumes to be planted; and

(3) Types and methods of planting, including the amount of grasses or legumes per acre, or the number and spacing of trees, or tree seedlings, or combinations of grasses and trees.

(d) In those instances in which the permit, lease, or contract requires regrading and backfilling, the mining plan shall show the proposed methods and the timing of grading and backfilling of areas to be affected by the operation.

(e) The mining supervisor or the district manager shall review the mining plan submitted to him by the operator and shall promptly indicate to the operator any changes, additions, or amendments necessary to meet the requirements formulated pursuant to § 23.5, the provisions of the regulations in this part and the terms of the permit, lease, or contract. The operator shall comply with the provisions of an approved mining plan.

(f) A mining plan may be changed by mutual consent of the mining supervisor or the district manager and the operator at any time to adjust to

changed conditions or to correct any oversight. To obtain approval of a change or supplemental plan the operator shall submit a written statement of the proposed changes or supplement and the justification for the changes proposed. The mining supervisor or the district manager shall promptly notify the operator that he consents to the proposed changes or supplement or, in the event he does not consent, he shall specify the modifications thereto under which the proposed changes or supplement would be acceptable. After mutual acceptance of a change of a plan the operator shall not depart therefrom without further approval.

(g) If circumstances warrant, or if development of a mining plan for the entire operation is dependent upon unknown factors which cannot or will not be determined except during the progress of the operation, a partial plan may be approved and supplemented from time to time. The operator shall not, however, perform any operation except under an approved plan.

§ 23.9 Performance bond.

(a) (1) Upon approval of an exploration plan or mining plan, the operator shall be required to file a suitable performance bond of not less than $2,000 with satisfactory surety, payable to the Secretary of the Interior, and the bond shall be conditioned upon the faithful compliance with applicable regulations, the terms and conditions of the permit, lease, or contract, and the explorations or mining plan as approved, amended or supplemented. The bond shall be in an amount sufficient to satisfy the reclamation requirements of an approved exploration or mining plan, or an approved partial or supplemental plan. In determining the amount of the bond consideration shall be given to the character and nature of the reclamation requirements and the estimated costs of reclamation in the event that the operator forfeits his performance bond.

(2) In lieu of a performance bond an operator may elect to deposit cash or negotiable bonds of the U.S. Government. The cash deposit or the market value of such securities shall be equal at least to the required sum of the bond.

(b) A bond may be a nationwide or statewide bond which the operator has filed with the Department under the provisions of the applicable leasing regulations in Subchapter C of Chapter II of this title, if the terms and conditions thereof are sufficient to comply with the regulations in this part.

(c) The district manager shall set the amount of a bond and take the necessary action for an increase or for a complete or partial release of a bond. He shall take action with respect to bonds for leases or permits only after consultation with the mining supervisor.

(d) Performance bonds will not be required of Federal, State or other governmental agencies. Where the exploration or mining is actually performed for such Federal, State, or governmental agencies by a Contractor who would have to post a bond under the terms of paragraph (a) of this section if he were the operator, such agencies shall require the Contractor to furnish a bond payable to the United States which meets the

requirements of paragraph (a) of this section. If, for some other purpose, the Contractor furnishes a performance bond, an amendment to that bond which meets the requirements of paragraph (a) of this section will be acceptable in lieu of an additional or separate bond.

With specific reference to all deposits located on land under the jurisdiction of the Bureau of Land Management the Contractor shall comply with the Bureau of Land Management's requirements of the General Surface Protection Clause as set forth herein.

General Surface Protection Clause

Protection of surface natural resources and improvements. The Contractor agrees to take such reasonable steps as may be needed to prevent operations on the servient lands from unnecessarily: (1) causing or contributing to soil erosion or damaging crops, including forage, and timber growth thereon or on Federal or non-Federal lands in the vicinity; (2) polluting air and water; (3) damaging improvements owned by the United States or other parties; or (4) destroying, damaging, or removing vertebrate fossils, historic or prehistoric ruins, or artifacts; and prior to completion of the project or at any other time prior thereto when required and to the extent deemed necessary by the Bureau of Land Management to fill any pits, ditches, and other excavations, remove or cover all debris, and so far as reasonably possible, restore the surface of the land and any access roads to their former conditions, including the removal of structures as and if required.

Antiquities and objects of historic value. When American antiquities or other objects of historic or scientific interest, including but not limited to historic or prehistoric ruins, vertebrate fossils, or artifacts, are discovered in the performance of the work, the item(s) or condition(s) will be left intact and immediately brought to the attention of the district manager or his authorized representative.

Where the Department has made arrangements with owners of land in the vicinity of a project for obtaining material from an owner's property, such arrangements are made solely for the purpose of providing all bidders an equal opportunity to obtain material from such property. Bidders or Contractors may, upon written request, inspect the documents evidencing such arrangements between property owners and the Department. The Contractor may, if he so elects, exercise any rights that have been obtained, which may be exercised by a Contractor under such arrangements, subject to and upon the conditions hereinafter set forth.

It is expressly understood and agreed that the Department assumes no responsibility to the bidder or Contractor whatsoever in respect to the Department's arrangements made with the property owner to obtain materials therefrom and that the Contractor shall assume all risks in connection with the use of such property.

The inclusion of documents setting forth the arrangements made with some property owners for obtaining material from such owners' properties as set forth in subsection 106.02, "Local Materials," of the special provisions shall

not in any respect operate as a waiver of any of the provisions in this section concerning said documents.

The bidder or Contractor is cautioned to make such independent investigation and examination as he deems necessary to satisfy himself as to the rights, duties, and obligations acquired or undertaken under such an arrangement with the property owner.

Notwithstanding that the Contractor may elect to obtain materials from any such property owner's property, no material may be obtained from such property unless the Contractor has first either:

(a) Executed a document that will guarantee to hold such owner harmless from all claims for injury to persons or damage to property resulting from the Contractor's operations on the property owner's premises and also agree to conform to all other provisions set forth in the arrangement made between the Department and the property owner. Said document will be prepared by the Engineer for execution by the Contractor; or

(b) Entered into an agreement with the owner of the material source on any terms mutually agreeable to the owner and the Contractor, provided that the Contractor shall furnish to the Engineer a release, in a form satisfactory to the Engineer, executed by the owner, relieving the Department of any and all obligations under the Department's arrangement with the owner.

If the Contractor elects to obtain material under (a), the use of such site shall be subject to the terms, conditions, and limitations of the arrangement made between the property owner and the Department and the Contractor shall pay such charges as are provided for in the arrangement made by the Department with the property owner.

If the Contractor elects to obtain material under (b), he shall pay such charges as are provided for in the agreement between the owner and the Contractor.

Unless otherwise provided and before acceptance of the contract, the Contractor shall submit written evidence that the owner of the material source is satisfied that the Contractor has satisfactorily complied with the provisions of either (a), the arrangement between the Department and the owner, or (b), the agreement between the owner and the Contractor, as the case may be.

Should the Contractor enter upon any of the areas withdrawn or otherwise obtained by the Department from the U.S. Government, it shall be his responsibility to determine the rights of others in the area. The Contractor shall not encroach on easements of others without their written permission and shall assume the responsibility for any damages due to his entering said area. In addition, the Contractor shall be bound by the terms, conditions, and reservations contained in the approved application for withdrawal.

Except as hereinafter provided, full compensation for furnishing all labor, materials, tools, equipment, and incidentals, including the construction of any access roads or fences and any clearing, grubbing, and stripping of material sources, and all processing of whatever nature and extent required, shall be considered as included in the price paid for the contract item of work involving the specified material and no additional compensation will be allowed therefor.

Materials to be incorporated in the project may come from: (a) Department-furnished sources, or (b) Contractor-furnished sources.

(a) Department-furnished sources. The Department may acquire and make available to the Contractor the use of materials pits, quarry sites, riprap sources, stockpile sites, plant sites, and haul roads.

The quality of material in deposits will be accepted in general, but the Contractor shall determine for himself the amount of equipment and work required to produce a material meeting the specifications. It shall be understood that it is not feasible to ascertain from samples the limits for an entire deposit, and that variations shall be considered as usual and are to be expected. The Engineer may order procurement of material from any portion of a deposit and may reject portions of the deposit as unacceptable.

If, after the Contractor has established his crushing and screening equipment in a pit, the Engineer determines that the Contractor is not able to produce acceptable material in the amount shown to be available, he will order the Contractor to move his equipment to another source designated by the Department. Payment for additional work required because of the move will be made as follows:

1. Movement of crushing units and auxiliary equipment will be paid for in accordance with subsection 109.03, "Extra and Force Account Work," of these specifications and the special provisions.

2. Stripping of the new material site and construction of new haul roads, where required, will be paid for at the contract unit prices for the method specified for the original site or in the absence of contract prices, as extra work.

3. An allowance for haul will be made for or against the Contractor, by multiplying the difference in haul lengths by the total tons or cubic yards hauled from the new source. The adjustment will then be made by multiplying this figure by a rate of $0.15 per ton mile or $0.23 per cubic yard mile.

The Engineer will determine the necessity for any move.

The Contractor will not be reimbursed for moving equipment within a pit area or for moves made for the benefit of the Contractor.

(b) Contractor-furnished sources. The plans or special provisions may provide that the Contractor furnish the material from any source of his choice.

If the Contractor elects to use material from sources other than those listed as available, he shall acquire the necessary rights to take materials from the sources and shall bear all costs related thereto, including royalties, stripping, developing, exploring, and increases in haul length. The Contractor shall also pay all costs for options or guarantees for pits moved or not used.

The use of material from such sources will not be permitted until representative samples, taken by the Engineer, prove that the material meets all applicable specifications and design requirements, and the Department certifies in writing that the material meets all of the design criteria used for the approval of the source set up on the plans. The Department will assume the cost of processing samples to determine the suitability of Contractor-furnished material.

Commercial sources shall be construed to mean Contractor-furnished sources and all requirements under this section shall be applicable thereto.

Where the Department has obtained the right to remove materials from lands owned or controlled by the U.S. Government, by withdrawal or otherwise, and these areas are set forth in the special provisions, the successful bidder on the project may enter upon and remove materials for use on this contract only, without further permission from the U.S. Government, except as follows:

The Contractor shall, at his sole expense, comply with all Federal, State, and local laws, ordinances, rules, regulations, zoning, etc., and shall be responsible for obtaining all licenses, permits, and paying all costs in relation thereto. There shall be no adjustment in contract unit prices bid, or any adjustment of the contract time allowed due to the use of designated deposits and said costs shall be considered included in the contract unit prices bid for other items of work and no further compensation shall be allowed therefor.

The Department may, in its discretion, grant the successful bidder written permission to enter on, and remove materials from, areas withdrawn or otherwise obtained by the Department but not designated in the special provisions. Approval to use any nondesignated source shall be subject to the following conditions:

(a) No such request shall be considered prior to award of the contract.

(b) No such request shall be considered unless it is accompanied by a written proposal which must show a substantial benefit to the public. The Department reserves the right to reject any proposal.

(c) Approval or rejection of any proposal shall not be considered sufficient cause for any adjustment of the contract time allowed to complete the contract.

(d) If the successful bidder's proposal (with mutually agreed revisions, if any) is accepted, the Department will execute a contract change order setting forth the terms and conditions regarding the use of said deposit(s). Once the contract change order has been fully executed, the successful bidder may proceed under the conditions contained therein.

In the event approval to use nondesignated sources results in a net cost savings, the Contractor shall receive fifty (50) percent and the Department fifty (50) percent.

(e) It is mutually understood and agreed by both parties to the contract, that the Department cannot guarantee the use of nondesignated deposits that may be considered due to factors beyond the Department's control.

Therefor, it is further agreed by both parties to the contract that should the Department fail to grant permission to use nondesignated deposits, both parties to the contract are released and held harmless from the terms and conditions of any contract change order which was executed in accordance with paragraph (d) above.

Except as hereinafter provided, full compensation for furnishing all labor, materials, tools, equipment, and incidentals, including the construction of any access roads or fences and any clearing, grubbing, and stripping of material sources, shall be considered as included in the price paid for the contract item of work involving the specified material and no additional compensation will be allowed therefor.

106.04 Samples and Tests. Except as provided in subsection 106.05, "Certificates of Compliance," all materials will be inspected, tested, and accepted by the Engineer before incorporation in the work. Any work in which untested and unaccepted materials are used without approval or written permission of the Engineer shall be performed at the Contractor's risk and may be considered as unacceptable and unauthorized and will not be paid for.

It is the intent of these specifications that the Contractor shall produce materials at the plant that conform in all respects to the requirements of the specifications; however, blending on the roadbed to correct for minor deficiencies in grading, sand equivalent or excess plasticity will be allowed under the following conditions:

(a) All blending material added on roadway and all work involved in processing such material will be at the expense of the Contractor.

(b) Processing of the material will continue until a homogeneous mixture is obtained. Uniform gradation shall be obtained to the degree that sieve analysis tests show less than ten (10) percent difference, plus or minus, in the amount of material passing the No. 16 sieve, determined by comparing sieve analysis tests on two (2) samples of processed and blended material. Samples for tests, taken for the above conditions, shall be confined within a distance of five hundred (500) feet of each other and also taken in the same continuous windrow.

When the Contractor requests progress samples taken at the crushing plant, the plant shall be provided with a mechanical means for obtaining samples. Samples of the finished product of the plant shall be obtained prior to or as the material leaves the conveyor belt for the bin or stockpile. The sampling device shall be so constructed that small representative samples may be taken frequently and these small samples combined to form the complete sample. The samples shall be delivered by mechanical means to a point on the ground or other safe and accessible spot satisfactory to the Engineer. Test results run from samples taken will be furnished to the Contractor's representative at his request. The results of such tests shall not be the basis for final acceptance of the material.

Sampling for final acceptance of materials will be as hereinafter outlined:

(a) Types 1, 2, and 3, Class B aggregate base courses and "selected material base or surface" will be sampled just prior to final laydown.

(b) Types 1, 2, and 3, Class A aggregate base courses will be sampled from the roadbed directly behind the laydown machine and prior to the first pass of the roller.

(c) Aggregate for cement or lime treated bases will be sampled as follows:

1. Where the material is being mixed at a stationary plant, samples will be taken from the conveyors just prior to delivery to the mixer and prior to adding lime and cement.

2. Where material is being mixed on the roadbed, samples will be taken after the material has been placed on the roadbed and processed and prior to adding cement or lime.

(d) Aggregates for roadmix bituminous mixtures (including base or surface) will be sampled after the material has been placed on the roadbed and processed and prior to adding the bituminous binder.

(e) Aggregate for plantmix bituminous open-graded will be sampled from the laydown machine.

(f) Aggregate for screenings will be sampled from the loaded truck just prior to placing.

(g) Aggregate for plantmix bituminous mixtures (base or surface) will be sampled for acceptance behind the paver. Samples for plasticity tests will be taken at the bins.

(h) Sampling of bituminous materials, intended for use in prime, tack or seal coats, surface treatments, and base, binder, or surface course mixtures, shall be done after the bituminous material has arrived at job destination and before, or at the time of unloading the materials.

One sample of material shall be taken from each railroad tank car or truck transport by the Contractor or his designated representative under the observation of and in a manner approved by the Engineer. Where delivery is made in smaller hauling units than those cited above, such as a distributor, or where the contents of a storage tank are sampled, the required sample shall be taken to represent a maximum of ten thousand (10,000) gallons. The Contractor shall take samples during the established job working hours, unless arrangements are made for a representative of the Department to witness the taking of the samples at another time.

The sample taken from each load shall be submitted to the Department's laboratory for testing. In the event the test results fail to comply with requirements, the remaining portion of the sample shall be tested to confirm the initial test results.

Sampling shall be done by one of the following three methods:

1. In accordance with the provisions of Test Method No. Nev. T723;
2. By bleeding through a drain-cock in the transfer line during the unloading of the approximate middle third of the load; or
3. By means of a sampling device inserted to a level of approximately the middle third of the load or tank.

The selection of the method of sampling to be used shall be at the option of the Contractor. Where sampling is done by bleeding, five (5) to ten (10) minutes shall elapse between the separate samplings.

It shall be understood and agreed that samples obtained by any one of the above designated methods are presented and accepted by the Contractor, and accepted by the Engineer, as being truly representative of the material delivered for incorporation in the work.

All sampling devices and sample containers will be furnished by the Department. Immediately after filling the sample container, it shall be tightly sealed, properly marked for identification, and presented to the Engineer.

One of the two samples, taken from each load, shall be submitted to the Department's laboratory for testing and the other sample retained by the Resident Engineer to be later submitted to the laboratory for confirming tests in the event the first sample tested should fail to comply with requirements. If the first sample tested complies with requirements, the second sample may be discarded.

Where less than eighty (80) percent of the asphalt deliveries are used on the project, samples shall be taken just prior to delivery to the mixer. Samples

shall be taken for every twenty-five (25) tons of asphalt delivered to the project.

(i) Tests for the aforementioned materials produced under conditions other than contemplated herein shall be taken at the time and place deemed by the Engineer to be most appropriate.

106.05 Certificates of Compliance. The Engineer may permit the use of certain materials or assemblies prior to sampling and testing if accompanied by a Certificate of Compliance stating that the materials involved comply in all respects with the requirements of the specifications. The certificates shall be signed by the manufacturer of the material or the manufacturer of assembled materials. A Certificate of Compliance must be furnished with each lot of material delivered to the work and the lot so certified must be clearly identified in the certificate.

All materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance shall not relieve the Contractor of responsibility for incorporating material in the work which conforms to the requirements of the plans and specifications and any such material not conforming to such requirements will be subject to rejection whether in place or not.

The Department reserves the right to refuse to permit the use of material on the basis of a Certificate of Compliance.

The form of the Certificate of Compliance and its disposition shall be as directed by the Engineer.

106.06 Cited Specifications. Unless otherwise specified, all tests shall be performed in accordance with the methods used by the Department of Transportation. All tests that are performed shall be made by the Engineer or his designated representative.

The Department of Transportation has developed test methods for testing the quality of materials and work. These test methods are identified by the prefix Nev. followed by the serial number. Copies of individual test methods are available at the Materials and Testing Division, Department of Transportation, Carson City, Nevada, and will be furnished to interested persons upon request.

Whenever a reference is made in the specifications to a test method by Nev. number, it shall mean the test method in effect on the date of the advertisement for bid.

Whenever a reference is made in the specifications to a specification or test designation either of the American Society for Testing and Materials, the American Association of State Highway and Transportation Officials, Federal specifications, or any other recognized national organization, and the number or other identification accompanying the test designation representing the year of adoption or latest revision of the test is omitted, it shall mean the test method in effect on the date of advertisement for bid.

When requested by the Engineer, the Contractor shall furnish, without charge, samples of all materials entering into the work, and no material shall be used prior to approval by the Engineer, except as provided in subsection

106.05, "Certificates of Compliance." Samples of material from local sources shall be taken by or in the presence of the Engineer; otherwise, the samples will not be considered for testing.

106.07 Plant Inspection. The Engineer may inspect the production of material or the manufacture of products at the source of supply. Plant inspection, however, will not be undertaken until the Engineer is assured of the cooperation and assistance of both the Contractor and the material producer. The Engineer or his authorized representative shall have free entry at all times to such parts of the plant as concerns the manufacture or production of the materials. Adequate facilities shall be furnished free of charge to make the necessary inspection.

It is understood that the Department reserves the right to retest all materials prior to incorporation into the work which have been tested and accepted at the source of supply after the same have been delivered and to reject all materials which, when retested, do not meet the requirements of these specifications, or the requirements of the contract documents.

106.08 Storage of Materials. Materials shall be so stored as to assure the preservation of their quality and fitness for the work. When considered necessary by the engineer, they shall be stored in waterproof buildings, placed on wooden platforms or other hard, clean surfaces, and not on the ground, and shall be covered when directed. Stored materials, even though approved for use before storage, may be inspected prior to their use in the work, and they shall meet the requirements of the specifications at the time of this proposed use. Stored materials shall be located so as to facilitate their prompt inspection. Upon approval of the Engineer, that portion of the right of way not required for public travel may be used for storage purposes and for placing of the Contractor's plant and equipment, but any additional space required therefor must be provided by the Contractor at his expense. Private or public property shall not be used for storage purposes without written permission of the owner or lessee. All storage sites shall be restored to their original condition by the Contractor at his expense. This shall not apply to the stripping and storing of top soil or to other material salvaged from the work or specifically prescribed under the specifications.

106.09 Handling Materials. All materials shall be handled in such manner as to preserve their quality and fitness for the work. Aggregates shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the qualities of materials intended for incorporation in the work as loaded, and the quantities as actually received at the place of operation.

106.10 Unacceptable Materials. All materials not substantially conforming to the requirements of the specifications at the time they are used shall be considered as unacceptable and all such materials will be rejected and shall be removed immediately from the site of the work unless otherwise

instructed by the Engineer. No rejected material, the defects of which have been corrected, shall be used until approval has been given by the Engineer.

106.11 Department Furnished Material. The Contractor shall furnish all materials required to complete the work, except those specified to be furnished by the Department. Material furnished by the Department will be delivered or made available to the Contractor at the points specified in the special provisions.

The cost of handling and placing all materials after they are delivered to the Contractor shall be considered as included in the contract price for the item in connection with which they are used.

The Contractor will be held responsible for all material delivered to him, and deductions will be made from any money due him to make good any shortages and deficiencies, from any cause whatsoever, and for any damage which may occur after such delivery and for any demurrage charges.

SECTION 107

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 Laws to be Observed. The Contractor shall keep fully informed of all Federal and State laws, all local bylaws, ordinances, and regulations, and all orders and decrees of bodies or tribunals having jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, bylaws, ordinances, regulations, orders, and decrees, and shall protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such law, bylaws, ordinances, regulations, orders, or decrees, whether by himself or his employees.

The Contractor's and subcontractors' compliance with Title 29, subtitle A, 3.3, code of Federal Regulations and NRS 338.095 will be required on this contract. These regulations require that the Contractor and subcontractors submit a weekly payroll and statement of compliance with respect to each employee engaged in work on the project. These payrolls and statements of compliance shall be submitted to the Nevada Department of Transportation and the State of Nevada Labor Commissioner.

107.02 Permits, Licenses, and Taxes. The Contractor shall procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including vehicular registration or prorate registration and carrier licensing as applicable. Privilege taxes are in addition to the above fees. Contractors having vehicles not licensed or registered in Nevada shall contact the Motor Carrier Division of the Department of Motor Vehicles and Public Safety, Carson City, Nevada, for full information.

107.03 Patented Devices, Materials, and Processes. If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the State, any affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material, or process, or any trademark or copyright, and shall indemnify the State for any costs, expenses, and damages which it may be obliged to pay by reason of any infringement at any time during the prosecution or after the completion of the work.

107.04 Restoration of Surfaces Opened by Permit. The right to construct or reconstruct any utility service in the highway or street, or to grant permits for same, at any time, is hereby expressly reserved by the Department for the proper authorities of the municipality or other political subdivision in which the work is done and the Contractor shall not be entitled to any

damages either for the digging up of the street or for any delay occasioned thereby.

Any individual, firm, or corporation wishing to make an opening in the highway must secure a permit from the Department. The Contractor shall allow parties bearing such permits, and only those parties, to make openings in the highways. The Contractor shall, when ordered by the Engineer, make in an acceptable manner, all necessary repairs due to such openings, and such necessary work will be paid for as extra work, or as provided in these specifications, and will be subject to the same conditions as original work performed.

107.05 Federal Aid Provisions. (a) Work Subject to Inspection and Approval of Federal Agency. When the United States Government pays all or any portion of the cost of the work, the Federal laws authorizing such participation and the rules and regulations made pursuant to such laws, must be observed by the Contractor. The work shall be subject to the inspection of the authorized representatives of such Federal agencies as are created for the administration of these laws, but such inspection will in no sense make the Federal Government a party to the contract and will in no way interfere with the right of either party hereunder.

(b) Fair Labor Standards Act. The attention of bidders is directed to the fact that this Department has been advised by the Wage and Hour Division, U.S. Department of Labor, that contractors or subcontractors engaged in highway construction work are required to meet the provisions of the Fair Labor Standards Act of 1938 (52 Stat. 1060) or as amended (Title 29, United States Code, Section 201, et seq.).

107.06 Sanitary, Health, and Safety Provisions. The Contractor shall provide and maintain in a neat, sanitary condition, such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the State Department of Human Resources and of other bodies or tribunals having jurisdiction thereover. He shall commit no public nuisance.

Attention is directed to Federal, State, and local laws, rules, and regulations concerning construction safety and health standards. The Contractor shall not require any workers to work in surroundings or under conditions which are unsanitary, hazardous, or dangerous to their health or safety.

107.07 Public Convenience and Safety. The Contractor shall at all times conduct the work in such a manner as will obstruct and inconvenience traffic as little as possible. The Contractor shall keep existing travel roads and streets, adjacent to or within the limits of the improvement, open to and in a good, dust free, and safe condition for traffic at all times. Attention is directed to subsection 107.21, "Dust Control." The Contractor shall maintain said roads and streets to the extent that he shall be responsible for the removal of any material or debris resulting from or caused by his operations and shall repair any damage which may result from his operations. For those roads and streets actually under physical improvement, attention is directed to subsection 104.04, "Maintenance of Traffic." Where grading operations are on or

adjacent to the existing travelled way, the grade should be finished immediately after the rough grading is completed and the surfacing material shall be placed thereon as the work progresses. The Contractor shall so conduct his operations as to have under construction no greater length or amount of work than he can prosecute vigorously and he shall not open up sections of the work and leave them unfinished, but he shall finish the work as he goes insofar as practicable.

The Contractor shall perform his work in a manner to assure full compliance with all applicable Federal, State, and local laws and regulations governing safety, health, and sanitation. He shall provide adequate safeguards, safety devices, and protective equipment such as are specified in other sections of these specifications, or other documents and take any other needed actions as the Engineer may determine reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

The Contractor shall at all times during the progress of the work or temporary suspension of the work, provide, erect, and maintain all necessary barricades, suitable and sufficient red lights, danger signals, temporary striping and signs, provide a sufficient number of flagmen, and take all necessary precautions for the protection of the work and safety of the public, and those engaged on the work. All barricades and obstructions shall be illuminated at night with reflectorized signs and lights, and all lights for this purpose shall be kept burning from sunset to sunrise. All barricades, warning signs, lights, temporary signals, and other protective devices must conform with the MUTCD Manual.

107.08 Relations with Railroads. (a) Definitions. The following definitions shall apply to the terms as herein used. *Railroad:* The railway or railroad company whose tracks are crossed or whose property is adjacent to the work or upon whose property the work is performed. *Chief Engineer:* The Chief Engineer of the railroad or his authorized representatives. *Railroad Crossing:* A crossing at grade of the tracks of a railroad and the highway. *Grade Separation:* A permanent structure to effect the separation of grades between the highway and the railroad.

(b) Work or Operations.

1. Work or operations on grade separations, railroad crossings, or upon railroad property shall be subject to inspection by the Chief Engineer, and shall be conducted and performed in a manner satisfactory to the Chief Engineer.

2. Construction operations shall be so arranged and conducted as to insure safe and uninterrupted operation of the railroad traffic. The Contractor shall be responsible for any damages which result either directly or indirectly from the Contractor's operations.

3. The Contractor shall notify the Chief Engineer in writing, at least forty-eight (48) hours before starting any work in the proximity of the tracks, setting forth specifically the time at which it is planned to start such work.

4. Unless otherwise provided, the Contractor shall not pile or store any

material, or park or use Contractor's equipment closer than ten (10) feet from the centerline of the tracks.

5. The track zone shall be kept clean of all loose material or debris at all times. The Contractor shall be responsible for any fouling of railroad ballast resulting from sandblasting and painting operations and shall reimburse the railroad for the replacement of all ballast so fouled.

6. In advance of any blasting, the Contractor shall notify the Chief Engineer in order that proper flagging protection may be provided by the railroad. Excavations in the proximity of the tracks shall be sheeted in a manner satisfactory to the Chief Engineer and plans therefor shall be submitted to and approved by him before any such excavation is commenced.

7. The Contractor shall make arrangements with the railroad for crossing railroad tracks at locations other than existing public crossings and shall bear all costs relative thereto.

8. The Contractor shall submit detail plans of falsework and of forms for track spans and piers or abutments to the Chief Engineer and no work thereon shall be commenced unless and until such plans have been approved by the Chief Engineer. Falsework plans thus approved shall not be deviated from without permission of the Chief Engineer. The temporary vertical and horizontal clearances specified by the Chief Engineer in approving the plans shall be maintained at all times. In the case of impaired vertical clearances above the top of rail, the railroad shall have the option to install telltales, or other such protective devices the railroad deems necessary, for the protection of trainmen or rail traffic.

9. The Contractor shall comply with the rules and regulations of the railroad with respect to the Contractor's work or operations on or adjacent to railroad property. The Contractor shall arrange with the railroad for the services of such qualified railroad employees as the Chief Engineer may prescribe to protect and safeguard the railroad's property, engines, trains, and cars. Payment for such services, including compensation, insurance, vacation and holiday time, railroad retirement and unemployment taxes, health and welfare, accounting and billing charges, shall be paid by the Department directly to the railroad except all costs incurred by the Contractor which are applicable to any private crossing agreement(s) not provided in the contract. Any costs incurred by the Contractor relative to private crossing agreements for crossings not provided in the contract shall be paid by the Contractor directly to railroad in accordance with railroad's payment requirements.

10. Upon completion of the work covered by the awarded contract to be performed by the Contractor upon railroad's property, the Contractor shall promptly remove from the railroad's property all tools, equipment, and other materials, whether brought upon said property by the Contractor or any subcontractor, and shall cause said property to be left in a clean and presentable condition.

(c) Work or Operations Performed by Railroad. The railroad may undertake certain work or operations incident to the project which are the subject of an agreement between the Department and the railroad. Details of such work or operations will be set forth in the special provisions and the Contractor shall discuss such items with the Chief Engineer in order to develop a plan

whereby the Contractor and the railroad accomplish the work or operations in their logical sequence and order.

Movement or adjustment of telephone, telegraph, or signal facilities owned, operated, or maintained by the railroad and not otherwise provided for on the plans or in the special provisions shall be at the cost and expense of the Contractor.

(d) Insurance. The Contractor shall provide and maintain during the effective life of the awarded contract such special or additional insurance as is required by subsection 107.11, "Responsibility for Damage Claims," herein. The Contractor shall furnish such evidence as may be required that such insurance has been provided.

(e) Qualification. As a prerequisite to award, the Contractor shall be satisfactory as to responsibility to perform work upon the railroad's property.

(f) Reference. The provisions of subsections 624.03.02, "Flagmen," and 624.03.03, "Pilot Cars," subsection 107.11, "Responsibility for Damage Claims," and the special provisions shall inure directly to the benefit of the railroad.

107.09 Liability Insurance. (a) Contractor's Public Liability and Property Damage Liability Insurance. The Contractor shall provide and maintain, during the effective life of the awarded contract, regular Contractor's public liability and property damage liability insurance to protect the Contractor and all of the Contractor's construction subcontractors for claims for personal injury, accidental death, and to property, which may arise from operations under said contract, whether such operations be by the Contractor or by such subcontractor or by anyone directly or indirectly employed by either of them.

Whenever construction operations covered under said contract are to be performed upon or in proximity to railroad property, the Contractor's public liability and property damage insurance shall provide for limits of coverage not less than specified in the railroad protective insurance endorsement appended to the special provisions.

The following insurance coverage shall apply to all portions of the project except that portion that is required to be covered by railroad protective public liability and property damage insurance.

The Contractor's public liability and property damage liability insurance coverage shall be not less than one million dollars ($1,000,000), single limit.

The Contractor shall name the Department of Transportation as an additional insured on the public liability and property damage liability policy or policies.

A certified copy of the certificate of insurance as herein required shall be obtained by the successful bidder and furnished to the Department prior to commencing work on the contract.

The certificate of insurance to be furnished the Department shall be sent directly to the State of Nevada, Department of Transportation, 1263 South Stewart Street, Carson City, Nevada 89712, Attention: Labor Compliance Officer.

The certificate of insurance shall contain a clause providing for thirty (30)

days advance written notification to the Department in the event of cancellation by either the insuring company or the insured.

Full compensation for all premiums which the Contractor is required to pay on all the insurance described herein shall be considered as included in the prices paid for the various items of work to be performed under the contract, and no additional allowance will be made therefor or for additional premiums which may be required by extensions of the policies of insurance.

(b) Railroad's Protective Public Liability and Property Damage Insurance. In all cases where construction operations covered by the awarded contract are to be performed upon or adjacent to the property of the railroad, the Contractor shall furnish evidence to the Department that, with respect to the operations the Contractor or any of the Contractor's subcontractors perform, the Contractor has provided for and in favor of the railroad a policy of public liability and property damage insurance, to which is attached an endorsement, in the same form and with the same limits of coverage as the railroad protective insurance endorsement appended to the special provisions.

(c) General. The insurance required under paragraph (b) above shall apply only to that portion of the highway project upon or adjacent to the railroad property.

Railroad's protective public liability and property damage insurance shall be subject to approval by the railroad before any work is commenced on or adjacent to railroad property.

Such insurance shall be carried, and the premiums therefor paid, by the Contractor until all work required to be performed under the terms of said contract is satisfactorily completed as evidenced by the formal acceptance of the Department and thereafter until all of said tools, equipment, and materials have been removed from the property of the railroad and such property left in a clean and presentable condition. The insurance shall be noncancelable and nonalterable for any cause whatsoever (including failure to pay premiums) either by the Contractor or by the insurance company without thirty (30) days' written notice to the railroad and the Department. In the event such insurance is canceled as herein provided, the Contractor shall provide other insurance, subject to the same conditions as provided herein, which shall be effective as of the days of such cancellation and cover the unexpired period of the term herein required. The Contractor shall furnish the Department at the time of execution of said contract, three (3) copies of each policy to which is attached an endorsement the same as the railroad protective insurance endorsement appended to the special provisions. Two (2) copies of each of such policies shall be forwarded by the Department to the Chief Engineer for the railroad's approval.

107.10 Explosives. When the use of explosives is necessary for the prosecution of the work, the Contractor shall exercise the utmost care not to endanger life or property, including new work. The Contractor shall be responsible for all damage resulting from the use of explosives.

All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided satisfactory to the Engineer and in general not closer than one thousand (1,000) feet

from the road or from any building or camping area or place of human occupancy.

The Contractor shall notify each property owner and public utility company having structures or facilities in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury.

107.11 Responsibility for Damage Claims. The Contractor shall indemnify, defend, and save harmless the Department, its officers, and employees, from all suits, actions or claims of any character brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the said Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any claims or amount recovered under the "Workman's Compensation Act," or any other law, ordinance, order, or decree; and so much of the money due the said Contractor under and by virtue of his contract as may be considered necessary by the Department for such purpose, may be retained for the use of State; or in case no money is due, his surety may be held until such suit or suits, action or actions, claim or claims, for the injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the Department; except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he is adequately protected by public liability and property damage insurance.

Reimbursement to the Contractor by the State in whole or in part for costs of protecting traffic shall not serve to relieve the Contractor of his responsibility as set forth in these specifications.

The Contractor guarantees the payment of all just claims for materials, supplies, and labor, and all other just claims against him or any subcontractor, in connection with this contract.

It is specifically agreed between the parties executing this contract that it is not intended by any of the provisions of any part of the contract to create the public or any member thereof a third party beneficiary hereunder, or to authorize anyone not a party to this contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of this contract.

107.12 Protection and Restoration of Property and Landscape. The Contractor shall be responsible for the preservation from injury or damage resulting directly or indirectly from the work under his contract of all public and private property, crops, trees, vegetation, monuments, fences, highway signs, and markers, etc., along and adjacent to the highway, and shall use every precaution necessary to prevent damage to pipes, conduits, and other underground structures, to poles, wires, cables, and other overhead structures, whether shown on the plans or not, shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location, and shall not remove them until directed. The Contractor shall not willfully or maliciously

injure or destroy trees or shrubs and he shall not remove or cut them without proper authority.

He shall be responsible for all damage or injury to property of any character during the prosecution of the work resulting from any act, omission, neglect, or misconduct in his manner or method of executing said work, or at any time due to defective work or materials, and such responsibility shall not be released until the project shall have been completed and accepted.

The Contractor shall be responsible for the preservation of archeological and paleontological objects, including all ruins, sites, buildings, artifacts, fossils, or other objects of antiquity encountered during construction. When such objects are encountered, the Contractor shall immediately cease operations and notify the Engineer that such objects exist. Construction operations shall be rescheduled to avoid the section until the removal of the artifacts or the gathering of historical data has been accomplished by the appropriate authority. When directed by the Engineer, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper authorities. Such excavation will be considered and paid for in accordance with subsection 104.03, "Extra Work."

Extension of contract time will be allowed for any delay to the Contractor due to preservation of archeological and paleontological objects.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the nonexecution thereof on part of the Contractor, he shall restore, at his expense, such property to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring as may be directed, or he shall make good such damage or injury in an acceptable manner. In case of failure on the part of the Contractor to restore such property or make good such damage or injury the Engineer may, upon forty-eight (48) hours' written notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary and the cost thereof shall be deducted from any money due, or which may become due the Contractor under the contract.

The Contractor shall restrict the movement of his vehicles and other construction equipment and personnel to the construction area and designated roads. Every precaution shall be taken to prevent the marking of the natural ground with equipment tracks or other means outside of the slope stake areas on either side of the roadway and in median areas where it is not required to disturb the existing ground. Where such markings of the natural ground are caused either by the Contractor's equipment, personnel, or operations, the Contractor, at his own expense, shall eradicate such marks to the satisfaction of the Engineer.

All roads from flat bottom ditches and material deposits shall be spaced at least one thousand (1,000) feet apart, except that such roads may also be located in ditch and dike areas. When roads are located in ditch and dike areas equipment shall not be allowed to travel outside the area to be occupied by said ditch or dike, except as provided for in subsection 203.03.12, "Chan-

nels." The crossing of median areas shall be at structures or areas approved by the Engineer.

Where there is a high potential for erosion and subsequent water pollution, the area of erosive land that may be exposed by construction operations at any one time shall be held to a minimum, and the duration of the exposure of the uncompleted construction to the elements shall be as short as practicable. Erosion control features shall be constructed concurrently with other work and at the earliest practicable time.

Disturbance of the lands and of waters that are outside the limits of the construction as staked is prohibited, except as may be found necessary and approved by the Engineer.

107.13 Forest Protection. Burning shall not be permitted as a method of disposal. The Contractor shall abide by such rules and instructions as to fire prevention and control as the authorized representative of the appropriate agency having jurisdiction may prescribe. The Contractor shall take all necessary steps to prevent his employees from setting fires during construction of the project and shall, under the direction of the appropriate Federal, State or other agency, or, in the absence of an officer from any such agency, acting independently, extinguish all fires set or caused by his employees and all other fires which may escape on the project, whether or not set directly or indirectly as a result of construction operations, without expense to the State or Federal Government. Where the Contractor is obligated to suppress any fire, without expense to the State or Federal Government, and if the amount of labor, subsistence, supplies, and transportation which he furnishes is inadequate in the opinion of the jurisdictional agency, then such agency may procure additional help or facilities and charge the expenses to the Contractor. These expenses shall be billed to the Contractor for payment directly by him, and if not promptly met by him shall be deducted from the money due or which may become due the Contractor under this contract, or collected from his sureties until the entire amount due for said fire suppression is recovered.

The Contractor shall maintain a fire patrol in the vicinity of blasting and other operations creating a fire hazard. When, in the opinion of the agency having jurisdiction, such a patrol is unnecessary because of weather conditions, the Contractor shall be so notified through the Engineer.

The Resident Engineer shall have authority to enforce correction of any condition which is, in his opinion, unsafe.

107.14 Disposal of Material Outside Highway Right of Way. The Contractor shall make his own arrangements for disposal of materials outside the highway right of way and he shall pay all costs involved.

When any material is to be disposed of outside the highway right of way, the Contractor shall first obtain a written permit from the property owner on whose property the disposal is to be made and he shall file with the Engineer said permit or the certified copy thereof together with a written release from the property owner absolving the State of any and all responsibility in connection with the disposal of material on said property. Before any material is disposed of on said property, the Contractor shall obtain written permission

from the Engineer to dispose of the material at the location designated in the said permit.

Such disposal sites will not be approved when located within one thousand (1,000) feet of a State highway right of way if the material placed thereon can be seen from said highway.

The following shall apply to all Contractor obtained disposal sites located outside the right of way except public or commercial dumping grounds which have been approved for general use by appropriate governmental authorities:

(a) All waste material with the exception of earth shall be buried with a minimum of one (1) foot of earth cover.

(b) The site shall be uniformly graded to drain and to blend with surrounding terrain.

(c) Slopes created by disposing of waste shall be finished to a ratio of not less than three to one (3:1).

(d) Prior to approval of such disposal sites, the following requirements shall be complied with:

1. The Department, at its sole expense, will conduct visual analysis and erosion control studies of the proposed site.

2. Once the Department has approved the proposed site regarding visual analysis and erosion control, the Contractor, at his sole expense, shall cause archeological and historic studies of the site and haul roads thereto to be made and such studies shall be submitted to the Engineer for approval. Written approval of said studies shall constitute approval of the site provided all other applicable requirements of these specifications are complied with.

Unless otherwise provided in the special provisions, full compensation for all costs involved in disposing of material as specified in this section, including all costs of hauling, shall be considered as included in the price paid for the contract items of work involving such materials and no additional compensation will be allowed therefor.

107.15 Relief from Maintenance and Responsibility. Upon the written request of the Contractor, or upon order of the Engineer, the Contractor may be relieved of the duty of maintaining and protecting certain portions of the work as described below, which have been completed in all respects in accordance with the requirements of the contract and to the satisfaction of the Engineer, and thereafter except with his consent, the Contractor will not be required to do further work thereon. In addition, such action by the Engineer will relieve the Contractor of responsibility for injury or damage to said completed portions of the work resulting from use by the public traffic or from the action of the elements or from any other cause, but not from injury or damage resulting from the Contractor's own operations or from his negligence.

Portions of the work for which the Contractor may be relieved of the duty of maintenance and protection as provided in the above paragraph include but are not limited to the following:

(a) The completion of one-fourth (1/4) mile of roadway or one-fourth (1/4) mile of one roadway of a divided highway or a frontage road including the travelled way, shoulders, drainage control facilities, planned roadway protection work, lighting, and any required traffic control and access facilities.

(b) A bridge or other structure of major importance.

(c) A complete unit of a traffic control signal system or of a highway lighting system.

(d) A complete unit of highway protection work.

(e) Any required traffic control and access facilities if the roadway or structure is to be used by public traffic before completion of the contract.

(f) Nonhighway facilities constructed for other agencies.

However, nothing in this subsection providing for relief from maintenance and responsibility will be construed as relieving the Contractor of full responsibility for making good defective work or materials found at any time before the formal written acceptance of the entire contract by the Engineer.

107.16 Contractor's Responsibility for the Work and Materials. Until the acceptance of the contract, the Contractor shall have the charge and care of the work and of the materials to be used therein (including materials for which he has received partial payment as provided in subsection 109.06, "Partial Payments," or materials which have been furnished by the State) and shall bear the risk of injury, loss, or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the nonexecution of the work, except as provided in subsection 107.15, "Relief from Maintenance and Responsibility." The Contractor shall rebuild, repair, restore, and make good all injuries, losses, or damages to any portion of the work or the materials occasioned by any cause before its completion and acceptance and shall bear the expense thereof, except as otherwise expressly provided in subsection 203.03.10, "Slides and Slipouts," and subsection 619.05.01, "Payment," for object markers and guide posts, and except for such injuries, losses, or damages as are directly and approximately caused by acts of the Federal Government or the public enemy. Where necessary to protect the work or materials from damage, the Contractor shall, at his expense, provide suitable drainage of the roadway and erect such temporary structures as are necessary to protect the work or materials from damage. The suspension of the work from any cause whatever shall not relieve the Contractor of his responsibility for the work and materials as herein specified. If ordered by the Engineer, the Contractor shall, at his expense, properly store materials which have been partially paid for by the State or which have been furnished by the State. Such storage by the Contractor shall be on behalf of the State and the State shall at all times be entitled to the possession of such materials, and the Contractor shall promptly return the same to the site of the work when requested. The Contractor shall not dispose of any of the materials so stored except on written authorization from the Engineer.

107.17 Contractor's Responsibility for Utility Property and Service. At points where the Contractor's operations are adjacent to properties of railroad, utility, and/or television cable companies, or are adjacent to other property, damage to which might result in considerable expense, loss, or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The Contractor shall not begin any operations which may interfere with or

impair the normal service being rendered by public or private utility operators, until such operators have been notified, and shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, and that duplication of rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted. The Contractor will be held responsible for the protection of the property of public or private utilities within the limits of the work.

In general, the repair and adjustment of street structures such as pipe lines, services, telephone, telegraph, and electric lines, above or below the ground, will be made by the owners thereof. When included in the proposal, the adjustment of sewer manhole frames and covers, inlets and catch basin frames and covers, and the like, will be within the Contractor's responsibility. The Contractor shall see that they are adjusted to conform to the lines, grades, and typical cross sections as shown on the plans, or as prescribed, without respect to whether the repairs and the roughing-in work have been performed by the Contractor or others.

Pipes or other construction shall be maintained in continuous service as far as practicable and shall be properly protected and supported. In no case shall interruption of the water service be allowed to exist outside of working hours.

Fire hydrants shall be accessible at all times to the fire department. No material or other obstruction shall be placed closer to a fire hydrant than permitted by ordinances, rules, or regulations, or within fifteen (15) feet of the fire hydrant in the absence of such ordinances, rules, or regulations.

The Contractor shall give notice in writing to the proper authorities in charge of streets, gas, water pipes, electric and other conduits, railroads, poles, manholes, catch basins, and all other property that may be affected by the Contractor's operations, at least forty-eight (48) hours before breaking ground.

In the event of interruption to water or utility services as a result of accidental breakage, the Contractor shall promptly notify the proper authority. He shall cooperate with said authority in the restoration of service as promptly as possible.

Utility installations shown on the plans are located according to best information obtained by the Department; however, it shall be considered normal and expected that elevations and alignment of said utilities may vary from that shown on the plans, and also that the Contractor may encounter utilities not shown on the plans. It shall also be considered normal and expected that utilities will prove to be an impediment to the Contractor's operations and that the Contractor may be forced to use other than the usual equipment and construction methods in accomplishing the necessary work over, around, or under such utility installations.

It shall be the obligation of the Contractor to locate and properly protect all utility installations. All utility installations that are damaged by, or due to, the Contractor's operations or negligence shall be repaired at his expense and no compensation will be allowed therefor.

Attention is directed to subsection 105.06, "Cooperation with Utilities."

107.18 Furnishing Right of Way. The Department will be responsible for the securing of all rights of way shown in the plans. Any exceptions will be indicated in the contract.

107.19 Personal Liability of Public Officials. In carrying out any of the provisions of these specifications or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the directors, Engineer, or their authorized representatives, either personally or as officials of the State, it being understood that in all such matters they act solely as agents and representatives of the State.

107.20 No Waiver of Legal Rights. The Department shall not be precluded or estopped by any measurements, estimate, or certificate made either before or after the completion and acceptance of the work and payment therefor, from showing the true amount and character of the work performed, and materials furnished by the Contractor, nor from showing that any such measurements, estimate, or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Department shall not be precluded or estopped, notwithstanding any such measurement, estimate or certificate, and payment in accordance therewith, from recovering from the Contractor or his sureties, or both, such damages as it may sustain by reason of his failure to comply with the terms of the contract. Neither the acceptance by the Department, or any representative of the Department, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the Department, shall operate as a waiver of any portion of the contract or of any power herein reserved, or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

107.21 Dust Control. Dust originating from any traffic or any plant or construction operations, either inside or outside the right of way, shall be controlled at all times by the Contractor in accordance with Federal, State, and local laws, ordinances, and regulations at the sole expense of the Contractor.

SECTION 108

PROSECUTION AND PROGRESS

108.01 Subletting of Contract. The Contractor shall not sublet, sell, transfer, assign or otherwise dispose of the contract or contracts or any portion thereof, or of his right, title, or interest therein, without prior written consent of the Engineer and of the surety.

Requests for permission to sublet, assign, or otherwise dispose of any portion of the contract shall be in writing and accompanied by a letter showing that the organization which will perform the work is particularly experienced for such work.

Consent to sublet, assign, or otherwise dispose of any portion of the contract shall not be construed to relieve the Contractor of his liability under the contract and bonds. The Contractor shall file with the Engineer within seven (7) days after making any subcontract, two (2) certified copies of such subcontract. In preparing such copies, the prices agreed upon for the work may be omitted.

All subcontractors and assignees of the prime or general Contractor shall be required to comply with the provisions of NRS 408.373 in the same manner as the prime or general Contractor.

Contract bid prices will prevail for purposes of computing the monetary value of all subcontracts.

The Contractor shall perform with his own organization, work amounting to not less than fifty (50) percent of the combined value of all items of the work covered by the contract except as follows:

(a) Should the Contractor elect to furnish materials for work to be performed by an approved subcontractor, and the materials are not obtained from the same firm that is to perform the work of incorporating said materials into the project, the cost of said materials, when set forth in a written statement accompanying the subcontract agreement or contained therein, will be excluded from amounts applicable to the subcontracted percentage.

When a firm both sells materials to a Contractor and performs the work of incorporating the materials into the project, these two phases of work must necessarily be considered in combination and, as in effect, constituting a single subcontract.

(b) When performed by subcontract, any items that have been selected as "specialty items" for the contract will be excluded from amounts applicable to the subcontracted percentage. "Specialty items" for the contract are listed as such in the special provisions.

Roadside production of materials is construed to be the production of crushed stone, gravel, or other material with portable or semiportable crushing, screening, or washing plants, established or reopened in the vicinity of the work for the purpose of supplying materials to be incorporated into the work on a designated project or projects. Roadside production of materials shall be considered subcontracting if performed by other than the Contractor.

The Department will not recognize any subcontractor on the work as a party

to the contract. Nothing contained in any subcontract shall create any contractual relation between the subcontractor and the Department. The Contractor will be held solely responsible for the progress of the work in accordance with progress required.

108.02 Notice to Proceed. An official "Notice to Proceed" specifying the date by which construction operations shall be started will be issued to the Contractor by the Engineer. Work shall be commenced not later than the date set forth in the "Notice to Proceed." The date set forth in the "Notice to Proceed" shall not be less than thirty (30) days after the "Notice to Proceed" is issued. Commencement of the work by the Contractor shall be deemed and taken as a waiver of such notice on his part, but in such case he shall notify the Engineer in writing at least forty-eight (48) hours in advance of the date on which he expects to begin work. In no case, however, shall the Contractor begin work prior to the date of approval of the contract. Contract time will begin on the date specified in the "Notice to Proceed," unless operations begin at an earlier date, in which case the date that such operations were begun will apply.

108.03 Prosecution and Progress. When required by the Engineer, the Contractor shall furnish the Engineer with a "progress schedule" for his approval. The progress schedule may be used as the basis for establishing major construction operations and as a check on the progress of the work. The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications within the time set forth in the special provisions. Should the prosecution of the work for any reason be discontinued, the Contractor shall notify the Engineer at least twenty-four (24) hours in advance of resuming operations.

108.04 Limitation of Operations. The Contractor shall conduct the work at all times in such a manner and in such sequence as will assure the least interference with traffic. He shall have due regard to the location of detours and to the provisions for handling traffic. He shall not open up work to the prejudice or detriment of work already started. The Engineer may require the Contractor to finish a section on which the work is in progress before work is started on any additional sections if the opening of such section is essential to public convenience.

No productive work will be required on Saturdays, Sundays or State recognized holidays. If, however, the Contractor elects to work on such days, those days worked will be charged as working days. The Contractor shall give the Engineer notice of his intention to work on the aforementioned days at least forty-eight (48) hours in advance of such work. State recognized holidays are enumerated in subsection 101.26, "Holidays," of these specifications.

The Engineer is authorized to notify the Contractor in writing and require the Contractor to cease construction operations the day before, during, and the day after said holidays, or at any other time if the Contractor's operations

are of such nature, the project is so located, and traffic is of such volume that it is deemed expedient to do so.

Traffic shall not be permitted on any part of the completed prime coat, plantmix bituminous base, plantmix bituminous surface, plantmix bituminous open-graded surface, seal coat, cement treated base or Portland cement concrete pavement until authorized by the Engineer.

Hauling vehicles transporting materials to and from the project either empty or loaded shall meet all the requirements and comply with all laws and regulations as would be required when traveling on a public street or highway for any other purpose.

During nonworking hours, all vehicles and equipment shall be parked a minimum of thirty (30) feet from the pavement edge of the traveled way over which public traffic is directed unless separated by guardrail or concrete barrier rail.

Employee parking shall be a minimum of thirty (30) feet from the pavement edge of the traveled way over which public traffic is directed unless separated by guardrail or concrete barrier rail.

After initial slopestake of horizontal and vertical controls, the Contractor shall give the State seventy-two (72) hours' written notice for any additional required controls. Saturdays, Sundays and Holidays will not be counted as part of the seventy-two (72) hours.

Disposal of concrete slabs, concrete foundations, old bituminous surfacing or other debris in median or interchange quadrant areas will not be permitted.

Existing fences shall not be removed until new or temporary fences have been constructed in a manner that will prevent pedestrians, children, livestock or pets from entering upon or crossing the right of way or straying from their appointed area. The Contractor shall provide such additional temporary fencing and gates as may become necessary to properly control such movement during construction. Unless otherwise specified in the special provisions, temporary fencing and gates shall not be measured for payment but the cost thereof shall be considered as included in the contract unit price bid for other items of work.

Where speed zones are established or where traffic is controlled either for safety of the traveling public or for protection of the work, the Contractor's equipment shall not exceed the speeds prescribed in the special provisions or ordered by the Engineer.

Installation of cross drainage pipe which carry water for irrigation and/or stockwater purposes shall be so carried out as to provide for a minimum stoppage of water, and satisfactory arrangements shall be made with the users of the water relative to their needs for such purposes.

108.05 Character of Workmen; Methods and Equipment. The Contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by these specifications.

All workmen shall have sufficient skill and experience to perform properly the work assigned to them. Workmen engaged in special or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

Any person employed by the Contractor or by any subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly, shall, at the written request of the Engineer, be removed forthwith by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the Engineer.

Should the Contractor fail to remove such person or persons as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may suspend the work by written notice until such orders are complied with.

All equipment which is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property, or other highway will result from its use.

When the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed in the contract, the Contractor is free to use any methods or equipment that he demonstrates to the satisfaction of the Engineer will accomplish the contract work in conformity with the requirements of the contract.

When the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the Contractor desires to use methods or types of equipment other than those specified in the contract, he may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved nor in contract time as a result of authorizing a change in methods or equipment under these provisions.

108.06 Temporary Suspension of Work. The Engineer shall have the authority to suspend the work wholly or in part, for such period as he may deem necessary, due to unsuitable weather or to such other conditions as are considered unfavorable for the suitable prosecution of the work, or for such time as he may deem necessary due to the failure on the part of the Contractor to carry out orders given, or to perform any provision of the contract. The Contractor shall immediately comply with the written order of the Engineer to suspend the work wholly or in part. The suspended work shall be resumed when conditions are favorable and methods are corrected, as ordered or approved in writing by the Engineer.

In the event that a suspension of work is ordered as provided above, and should such suspension be ordered by reason of the failure of the Contractor to carry out orders or to perform any provision of the contract, or by reason of weather conditions being unsuitable for performing any item or items of work, which work, in the sole opinion of the Engineer, could have been performed prior to the occurrence of such unsuitable weather conditions had the Contractor diligently prosecuted the work when weather conditions were suitable, the Contractor, at his own expense, shall do all the work necessary to provide a safe, smooth, and unobstructed passageway through construction for use by public traffic during the period of such suspension as provided in subsection 107.07, "Public Convenience and Safety," and as specified in the special provisions for the work. In the event that the Contractor fails to perform the work above specified, the Department will perform such work and the cost thereof will be deducted from money due or to become due the Contractor.

In the event that a suspension of work is ordered by the Engineer due to unsuitable weather conditions, and in the sole opinion of the Engineer, the Contractor has prosecuted the work with energy and diligence prior to the time that operations were suspended, the cost of providing a smooth and unobstructed passageway through the work will be paid for as extra work as provided in subsection 104.03, "Extra Work," or at the option of the Engineer, such work will be performed by the Department at no cost to the Contractor.

If the Engineer orders a suspension of all of the work or a portion of the work which is the current controlling operation or operations, due to unsuitable weather or to such other conditions as are considered unfavorable to the suitable prosecution of the work, the days on which the suspension is in effect shall not be considered working days as defined in subsection 101.66, "Working Day." If a portion of work at the time of such suspension is not a current controlling operation or operations, but subsequently does become the current controlling operation or operations, the determination of working days will be made on the basis of the then current controlling operation or operations.

If a suspension of work is ordered by the Engineer, due to the failure on the part of the Contractor to carry out orders given or to perform any provision of the contract, the days on which the suspension order is in effect shall be considered working days if such days are working days within the meaning of the definition set forth in subsection 101.66, "Working Day."

In the event of a suspension of work under any of the conditions set forth in this section, such suspension of work shall not relieve the Contractor of his responsibilities as set forth in Section 107, "Legal Relations and Responsibility to the Public."

108.07 Preconstruction Conference. After the contract has been awarded and prior to commencing work, the Engineer may designate a time and place satisfactory to the Contractor for a preconstruction conference. At such time the Engineer will outline detailed requirements to be followed in performance of the contract.

108.08 Determination and Extension of Contract Time. The contract

time for completion will be fixed by the Department, and will be stated in the special provisions, either as a calendar date or based on a number of working days. Attention is directed to subsection 101.66, "Working Day."

The Contractor shall perform the work in an acceptable manner within the time stated in the contract except that the contract time for completion may be adjusted as follows:

(a) Based on the merits of specific circumstances encountered during the term of the contract, the Engineer may adjust the contract time allowed to complete the work. Any such adjustment of time shall be in writing.

(b) In case of suspension of major items of work by order of the Engineer and through no fault of the Contractor, the time for completion shall be extended an amount equal to the elapsed time between effective dates of order to suspend and order to resume.

(c) When delays occur due to unforeseen causes beyond the control and without the fault or negligence of the Contractor, including, but not restricted to acts of God, acts of the public enemy, acts of government agency, fires, floods, epidemics, strikes, and freight embargoes, the time for completion shall be extended an amount determined by the Engineer to be equivalent to the delays; provided, however, written request for such extension of time is made by the Contractor within ten (10) calendar days after the beginning of such delay. No allowance shall be made for delay or suspension of the work due to fault of the Contractor.

Certain critical materials such as, steel, copper, aluminum, and bituminous products may be difficult to obtain due to a nationally recognized shortage or defense needs. The Contractor shall make every reasonable effort necessary to order and procure all such critical materials sufficiently in advance so as not to delay the completion of the project. Should a delay occur in obtaining critical materials that were properly ordered by the Contractor, the time for completion of the contract may be extended an amount determined by the Engineer to be equivalent to the delay in project progress due to said delay in obtaining critical materials provided that:

1. The delay in furnishing critical materials was due to defense needs or nationally recognized shortage.
2. The Contractor furnishes evidence to the Engineer's satisfaction that he had taken adequate steps for a guaranteed delivery date from his supplier.
3. Paragraph "1" above is properly certified to by not less than three (3) suppliers of the material or if three (3) suppliers are not available, the Contractor shall so certify and supply certification from such suppliers as there are.
4. The Department does not find a source when notified of the shortage by the Contractor.
5. The Contractor obtains such material from the first source available after such certification.

The contract time shall begin as set forth in subsection 108.02, "Notice to Proceed." When the final acceptance has been duly made by the Engineer as prescribed in subsection 105.16, "Final Acceptance," the daily time charge shall cease.

Working days will not be charged for seeding deposit areas, haulroads, and

that work set forth in subsection 104.06, "Final Clean Up," provided that all other work has been completed.

108.09 Failure to Complete the Work on Time. Time is an essential element of the contract and it is important that the work be pressed vigorously to completion. The cost to the Department of the administration of the contract, including engineering, inspection, and supervision, will be increased as the time occupied in the work is lengthened. The public is subject to detriment and inconvenience when full use cannot be made of an incomplete project.

Should the Contractor fail to complete the work within the time agreed upon in the contract or within such extra time as may have been allowed by increases in the contract or by formally approved extensions granted by the Department, there shall be deducted from any money or amounts due or that may become due the Contractor, the sum set forth in the special provisions for each and every working day that the work shall remain uncompleted. This sum shall be considered and treated not as a penalty but as liquidated damages due the State from the Contractor by reason of inconvenience to the public, added cost of engineering and supervision, and other items which have caused an expenditure of public funds resulting from his failure to complete the work within the time specified in the contract.

Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Department of any of its rights under the contract.

Working days will not be charged for seeding deposit areas, haulroads, and that work set forth in subsection 104.06, "Final Clean Up," provided that all other work has been completed.

108.10 Default and Termination of Contract. If the Contractor:

(a) Fails to begin the work under the contract within the time specified in the Notice to Proceed, or

(b) Fails to perform the work with sufficient workmen and equipment or with sufficient materials to assure the prompt completion of said work, or

(c) Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or

(d) Discontinues the prosecution of the work, or

(e) Fails to resume work which has been discontinued within a reasonable time after notice to do so, or

(f) Becomes insolvent or is declared bankrupt or commits any act of bankruptcy or insolvency, or

(g) Allows any final judgment to stand against him unsatisfied for a period of five (5) days, or

(h) Makes an assignment for the benefit of creditors, or

(i) Fails to comply with contract requirements regarding minimum wage payments or E.E.O. requirements, or

(j) For any other cause whatsoever, fails to carry on the work in an

acceptable manner, the Engineer will give notice in writing to the Contractor and his surety of such delay, neglect, or default.

If the Contractor or surety, within a period of ten (10) days after such notice, shall not proceed in accordance therewith, then the Engineer shall have full power and authority without violating the contract, to take the prosecution of the work out of the hands of the Contractor. The Engineer may, at his option, call upon the surety to complete the work in accordance with the terms of the contract; or he may take over the work, including any or all materials and equipment on the project as may be suitable and acceptable, and may complete the work by force account, or may enter into a new agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as, in his opinion, will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work under the contract, shall be deducted from any money due or which may become due said Contractor. In case the expense so incurred by the Department shall be less than the sum which would have been payable under the contract if it had been completed by said Contractor, then said Contractor shall be entitled to receive the difference, and in case such expense shall exceed the sum which would have been payable under the contract, then the Contractor and his surety shall be liable and shall pay to the State the amount of said excess.

In addition to the provisions set forth in these specifications, the Department may, by written order, terminate the contract or any portion thereof after determining that, for reasons beyond either Department or Contractor control, Contractor is prevented from proceeding with or completing the work as originally contracted for, and that termination would therefore be in public interest. Such termination must be with the concurrence of the Board of Directors and with the approval of the Federal Highway Administration when applicable.

If a contract, or a portion thereof, is terminated, it shall be subject to the following conditions:

1. When a contract, or a portion thereof, is terminated before completion of all items of work in the contract, all completed items of work as of that date will be paid for at the contract bid price. Payment for partially completed work will be made either at agreed prices or by force account methods described elsewhere in these specifications. Items which are eliminated in their entirety by such termination shall be paid for as provided in subsection 109.04, "Eliminated Items." In no event will loss of anticipated profits be considered as part of any settlement.

2. Acceptable materials obtained or ordered by the Contractor for the work and that are not incorporated in the work shall, at the option of the Contractor, be purchased from the Contractor based upon the delivered cost of the materials at such points of delivery as may be designated by the Director. The Contractor shall do everything possible to cancel unfilled orders.

3. Termination of a contract or a portion thereof shall not relieve the Contractor of his responsibilities for the work completed nor shall it relieve

his surety of its obligation for and concerning any claims arising out of the work performed.

4. Any claim for loss or damages not covered above or elsewhere in these specifications shall be submitted to the Director within sixty (60) days after receipt of the Order of Termination by the Contractor for the Director's acceptance or rejection. It is the intent of this subsection that an equitable settlement between the parties be reached pursuant to negotiation.

108.11 Termination of the Contractor's Responsibility. Whenever the improvement contemplated and covered by the contract shall have been completely performed on the part of the Contractor and all parts of the work have been approved and accepted by the Engineer, according to the contract, and the final estimate paid, the Contractor's obligations shall then be considered fulfilled, except as set forth in his contract bond and as provided in subsection 107.11, "Responsibility for Damage Claims."

108.12 Right of Way Delays. If, through the failure of the State to acquire or clear right of way, the Contractor sustains loss which could not have been avoided by the judicious handling of forces, equipment, and plant, there shall be paid to the Contractor such amount as the Engineer may find to be a fair and reasonable compensation for such part of the Contractor's actual loss, as, in the opinion of the Engineer, was unavoidable, determined as follows:

Compensation for idle time of equipment will be determined in the same manner as determinations are made for equipment used in the performance of extra work paid for on a force account basis, as provided in subsection 109.03, "Extra and Force Account Work," with the following exceptions:

(a) The time for which such compensation will be paid will be the actual normal working time during which such delay condition exists, but in no case will exceed eight (8) hours in any one (1) day.

(b) The days for which compensation will be paid will be the working days charged to the contract except that no compensation will be paid for Saturdays, Sundays, or holidays, regardless of working days charged.

Actual loss shall be understood to include no items of expense other than idle time of equipment and necessary payments for idle time of men, cost of extra moving of equipment, and cost of longer hauls. Compensation for idle time of equipment will be determined as provided in this subsection and compensation for idle time of men will be determined as provided in subsection 109.03, "Extra and Force Account Work," and no markup will be added in either case for overhead and profit.

If performance of the Contractor's work is delayed as the result of the failure of the Department to acquire or clear right of way, an extension of time determined pursuant to the provisions in subsection 108.08, "Determination and Extension of Contract Time," will be granted.

108.13 National Emergency and Termination of Contract. The State may, by written notice, with the approval of the Federal Highway Administration where applicable, terminate the contract or a portion thereof when the

Contractor is prevented from proceeding with the construction contract as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense.

When contracts, or any portion thereof, are terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract unit price, or as mutually agreed for items of work partially completed or not started. No claim for loss of anticipated profits shall be considered.

Reimbursement for organization of the work (when not otherwise included in the contract) and moving equipment to and from the job will be considered where the volume of work completed is too small to compensate the Contractor for these expenses under the contract unit prices, the intent being that an equitable settlement will be made with the Contractor.

Acceptable materials, obtained by the Contractor for the work, that have been inspected, tested, and accepted by the Engineer, and that are not incorporated in the work may, at the option of the engineer, be purchased from the Contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the Engineer.

Termination of a contract or a portion thereof shall not relieve the Contractor of his responsibilities for the completed work, nor shall it relieve his surety of its obligation for and concerning any just claims arising out of the work performed.

SECTION 109

MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities. The measurement and determination of the number of units of each pay item will be made in general as prescribed hereinafter and specifically as set out under Method of Measurement and Basis of Payment in the specification of each pay item.

After the items of work are completed and before final payment is made, the Engineer will determine the quantities of the various items of work performed as the basis for final settlement for all other than lump sum contracts. In the case of unit price items, the Contractor will be paid for the actual amount of work performed and materials used in accordance with these specifications, as shown by the final measurements, unless otherwise specified.

Actual authorized quantities of work satisfactorily completed under the contract shall be measured by the Engineer in accordance with United States Standard Measures and well recognized engineer practices. Unauthorized wastings of material will be deducted and only such quantities as are actually incorporated in the completed work will be included in the final estimate.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures having an area of nine (9) square feet or less. Unless otherwise specified, transverse measurements for area computation will be the neat dimensions shown on the plans or ordered in writing by the Engineer.

In computing volumes of excavation, embankment, and borrow, the average end area method will be used unless otherwise specified.

All items which are measured by the linear foot such as pipe culverts, underdrains, guardrails, etc., shall be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans.

The term "gage," when used in connection with the measurement of plates, shall mean the U.S. Standard Gauge. When reference is made, however, to the measurements of galvanized sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing, the term "gage" shall mean that specified in the respective test designation for that material as described in the "materials" section of these specifications.

When the term "gage" refers to the measurement of wire, it shall mean the wire gage specified in the AASHTO Designation: M32 for cold drawn steel wire for concrete reinforcement.

When water meters are required, the accuracy of the meters shall be checked by comparing the actual weight of approximately one thousand (1,000) gallons, or one hundred twenty-five (125) cubic feet, as metered with the calculated weight using as a reference density eight and thirty-three hundredths (8.33) pounds per gallon or sixty-two and four tenths (62.4) pounds per cubic foot. Unless otherwise specified, water meters shall be accurate to within two (2) percent of the indicated amount. The frequency of checking water meters will be determined by the Engineer.

The term "ton" shall mean the short ton consisting of two thousand (2,000)

pounds avoirdupois. All materials which are specified for measurement by ton shall be weighed on accurate, approved scales set at locations designated by the Engineer. All materials shall be weighed on platform scales with the following exception: In lieu of platform scales, the Contractor may provide an automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching control system. Such evidence shall be evidenced by a weigh ticket for each load. The Contractor shall have on hand not less than ten (10) fifty (50) pound standard weights for testing the scales.

All scales shall be furnished by and at the expense of the Contractor and shall have a certificate of inspection by the Bureau of Weights and Measures. The scales shall be tested and inspected by the Bureau of Weights and Measures and a new inspection certificate required as often as the Engineer may deem necessary, and after each scale move, in order to insure the accuracy of the scales. The cost of inspecting the scales shall be borne by the Department.

Platform scales shall be of sufficient size and capacity to weigh, in one operation, the entire loaded vehicle. Combination vehicles may be weighed as separate units, provided the connecting device between vehicles is so constructed that no weight other than that of the device itself is transmitted to either vehicle. When combination vehicles are used, approaches to and from the scale platform shall be level for sufficient distance to accommodate that portion of the combination vehicle that is off the scale platform. In instances where combination vehicles are weighed, the approaches to and from the scale platform must be level with the scale platform for a minimum distance of fifty (50) feet from each end of the scale platform.

If combination vehicles are utilized, provisions must be made to insure that all braking devices are disengaged during weighing operations as insurance against stresses being transmitted between either vehicle.

The scale pit must be of sufficient width to permit access to all scale components for purposes of inspection, repair, cleaning, and adjusting.

Support members for platform scales shall consist of twelve by twelve inch (12″ x 12″) or six by sixteen inch (6″ x 16″) (minimum) timbers placed on a firm gravel foundation. Scales consisting of more than one (1) section shall be supported with twelve by twelve inch (12″ x 12″) or six by sixteen inch (6″ x 16″) (minimum) timbers at each end of each section to avoid settlement of the scale platform. Concrete support members conforming to the minimum timber size requirements may be utilized in lieu of timber at the Contractor's option.

Platform scales shall be equipped with weatherproof housing so constructed as to protect the recording device and permit the weighmaster convenient access to all beams and dials. The housing shall not be less than six (6) feet wide, eight (8) feet long, and seven (7) feet high, and shall have two (2) windows, adjustable for ventilation, one (1) facing the scales, and shall be equipped with an adequate shelf suitable to the Engineer. The Contractor shall provide heat and electric lights when requested by the Engineer.

Conveyor scales of an approved type may be used. The conveyor scales shall be furnished with one (1) master counter to run continuously and one (1) remote counter which will print the weight in individual loads, then reset to

zero (0) automatically. The remote unit shall be placed in a weatherproof house with two (2) windows. One (1) window shall face the point of loading and the conveyor scales. This window shall also be equipped with a shelf two (2) feet wide and six (6) feet long. A controlled method of heating shall be supplied for cold weather operations.

A locked door shall be provided on the access to the conveyor balances (where fine adjustment must be made), the key to be in the hands of the Engineer and to be opened only for maintenance and adjustment of conveyor scales to meet the accuracy of the platform scales. This door shall be locked at all other times during the operation of the conveyor scales.

If conveyor weighing equipment is used, the following procedures shall be followed:

(a) The conveyor scales shall be calibrated against the platform scales, which must have a certificate of inspection.

(b) At the beginning and middle of each shift, or as requested by the Engineer, two (2) consecutive loads of material weighed over the conveyor scales shall be reweighed on the platform scales. The total weight indicated by the conveyor scales on the two (2) loads must check with the platform scale weight within one half of one (1/2) percent. If the conveyor scales weigh out of this tolerance, all loads shall be weighed on the platform scales until the condition is rectified.

(c) Consecutively numbered, individual weigh tickets must be used with conveyor scale weights stamped by the remote counter.

Unless otherwise specified, materials shipped by rail shall be weighed over the authorized project scales before incorporation into the work.

Cement will be measured by the barrel or ton. The term "barrel" will mean three hundred seventy-six (376) pounds of cement.

Timber will be measured by the thousand feet board measure (Mfbm) actually incorporated in the structure with no allowance for any waste except beveled ends. Measurement will be based on nominal widths and thicknesses, and the extreme length of each piece.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

All materials for which measurements are obtained by the cubic yard "loose measurement" or "measured in the vehicle" shall be hauled in approved vehicles and measured therein at the point of delivery. No allowance will be made for the settlement of material in transit. Vehicles for this purpose may be of any size or type acceptable to the Engineer, provided that the body is of such shape that the actual delivered contents may be readily and accurately determined and will remain constant. Unless all approved vehicles on the work are of uniform capacity, each vehicle must bear a plainly legible identification mark, indicating its specified approved capacity. All vehicles must be loaded to at least their water level capacity and all loads shall be leveled when the vehicles arrive at the point of delivery. Loads not hauled in approved vehicles or of a quantity less than the specific approved quantity for the hauling vehicle will be subject to rejection and no compensation will be allowed for the hauling of the material.

The unit of measurement for liquid asphalts, asphaltic emulsions, and paving asphalts shall be a ton or gallon.

Quantities of bituminous binders wasted or disposed of in a manner not called for under these specifications, or remaining on hand after completion of the work, will not be paid for.

When permitted by the Engineer, pay quantities of bituminous binder may be determined from volumetric measurements of the bituminous binder, in which case the bituminous binder shall be delivered in calibrated tanks and each tank shall be accompanied by its proper measuring stick and a calibration card signed by a sealer of weights and measures, and pay quantities shall be determined in accordance with the following procedure.

Volumetric measurements at any temperature shall be reduced to the volume the material would occupy at sixty (60) degrees Fahrenheit, before converting the volumetric measurements to weight.

The following tables shall be used to convert volumes from gallons to weight. All types, SC, MC, and RC of the same grade, shall be considered to have equal weights and volume.

Average Weights and Volumes of Liquid Asphalt

Grade of Liquid Asphalt	Gallons Per Ton at 60° F.	Barrels Per Ton at 60° F. (42 U.S. Gals.)	Pounds Per Gal. at 60° F.
70	253	6.03	7.90
250	249	5.93	8.03
800	245	5.83	8.16
3000	241	5.74	8.30

Average Weights and Volumes of Asphalt Cement

Grade	Gallons Per Ton at 60° F.	Barrels Per Ton at 60° F. (42 U.S. Gals.)	Pounds Per Gal. at 60° F.
AR-16,000	235	5.60	8.51
AR-8,000	235	5.60	8.51
AR-4,000	235	5.60	8.51
AR-2,000	237	5.64	8.44
AR-1,000	239	5.70	8.36

Average Weights and Volumes of Asphaltic Emulsion

Type of Emulsion	Gallons Per Ton at 60° F.	Barrels Per Ton at 60° F. (42 U.S. Gals.)	Pounds Per Gal. at 60° F.
All grades	240	5.71	8.33

When converting the volume of liquid asphalt, asphalt cement, or asphaltic emulsion at any temperature to the volume at sixty (60) degrees Fahrenheit a conversion factor for correlation shall be used. Said conversion factors shall be those prescribed in "The Asphalt Institute (Pacific Coast Division)" publication of "Specification Tables and Uses," current edition.

Rental of equipment will be measured by time within one-half (1/2) hour of actual working time and necessary travelling time of the equipment within the limits of the project. If equipment has been ordered on the job on a standby basis by the Engineer, half-time rates for the equipment will be paid.

When special equipment has been ordered by the Engineer in connection

with force account work, travel time and transportation to the project will be measured as hereinafter outlined. For the use of special equipment moved in on the work and used exclusively for extra work paid for on a force account basis, the Contractor will be paid the rental rates determined as provided in subsection 109.03, "Extra and Force Account Work," and for the cost of transporting the equipment to the location of the work and its return to its original location, all in accordance with the following provisions:

(a) The original location of the equipment to be hauled to the location of the work shall be agreed to by the Engineer in advance.

(b) The State will pay the costs of loading and unloading such equipment.

(c) The cost of transporting equipment in low bed trailers shall not exceed the hourly rates charged by established haulers.

(d) The rental period shall begin at the time the equipment is unloaded at the site of the extra work, shall include each day that the equipment is at the site of the extra work, excluding Saturdays, Sundays, and legal holidays unless the extra work is performed on such days, and shall terminate at the end of the day on which the Engineer directs the Contractor to discontinue the use of such equipment. The rental time to be paid per day will be in accordance with the following:

Hours Equipment Is in Operation	Hours to be Paid
0	4
0.5	4.25
1	4.5
1.5	4.75
2	5
2.5	5.25
3	5.5
3.5	5.75
4	6
4.5	6.25
5	6.5
5.5	6.75
6	7
6.5	7.25
7	7.5
7.5	7.75
8	8
Over 8	Hours in operation

When hourly rates are listed, less than thirty (30) minutes of operation shall be considered to be one-half (½) hour of operation.

(e) Should the Contractor desire the return of the equipment to a location other than its original location, the State will pay the cost of transportation in accordance with the above provisions, provided such payment shall not exceed the cost of moving the equipment to the work.

(f) Payment for transporting and loading and unloading equipment as above provided will not be made if the equipment is used on the work in any other way than upon extra work paid for on a force account basis.

Material wasted or disposed of in a manner not called for under the contract, material not unloaded from the transporting vehicle, material placed

outside of the limits indicated or given on the plans, or material remaining on hand after completion of the work will not be paid for except as otherwise provided.

109.02 Scope of Payment. Unless otherwise provided under "Basis of Payment," payments to the Contractor will be made for the actual quantities of contract items performed in accordance with the plans and specifications, and if, upon completion of the construction, these actual quantities show either an increase or decrease from the quantities given in the bid schedule, the contract unit prices will still prevail, except as provided in subsections 109.04, "Eliminated Items," and 104.02, "Increased or Decreased Quantities and Change in Character of Work."

Except as provided in subsection 107.16, "Contractor's Responsibility for the Work and Materials," the Contractor shall accept the compensation, as herein provided, in full payment for the following:

(a) The work complete, including all supervision, labor, material, tools, equipment, and incidentals necessary for all work contemplated and embraced under the contract;

(b) Any loss or damage due to the nature of the work, the action of the elements, strikes, or lockouts;

(c) Accidents to employees or the public, or both;

(d) Unforeseen difficulties or obstructions which may arise or be encountered during the prosecution of the work;

(e) All risks whatsoever connected with the work under contract until it is accepted by the Engineer;

(f) All expenses incurred by or in consequence of, the suspension or discontinuance of the prosecution of the work as herein specified, and in completing the work and the whole thereof, including the carrying out of all the requirements of these "general requirements and covenants" in an acceptable manner according to the plans and specifications.

If the "Basis of Payment" clause in the specifications relating to any unit price in the bid schedule requires that the said unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not also be measured or paid for under any other pay item except as provided for in subsection 104.05, "Rights in and Use of Materials Found in the Work."

The payment of any partial estimate or of any retained percentage, except by and under the approved final estimate and voucher, in no way shall affect the obligation of the Contractor to repair or renew any defective parts of the construction or to be responsible for all damages due to such defects.

Those subsections containing pay items of bituminous materials are subject to the following requirements:

It is agreed by the parties to the contract that (a) in case the bituminous material does not conform to the requirements set forth in Section 703, "Bituminous Materials," damage will be sustained by the Department, and that (b) it is extremely difficult to ascertain the actual damage which the Department will sustain; therefore, it is agreed the Contractor will pay to the Department as liquidated damages or the Department, at its option, may

deduct from any money due or to become due the Contractor from the Department an amount set forth in the following schedule:

Number of Demerits (From Section 703, "Bituminous Materials")	Liquidated Damage (per bid unit)
1–2	$5
3–5	10
6–9	15
10–14	25
15–20*	50

*Material shown by test to have twenty-one (21) or more demerits shall be removed and replaced or, at the option of the Engineer, may be left in place. Payment for such material left in place will be assessed liquidated damages at fifty (50) dollars per ton. Material removed will not be paid for and the removal thereof will be at the Contractor's expense.

109.03 Extra and Force Account Work. Extra work shall be paid for in accordance with the accepted contract change order. Work specified in the order to be performed at agreed unit prices shall be paid for in the same manner as proposal items.

When extra work paid for on a force account basis is performed by forces other than the Contractor's organization, the Contractor shall reach agreement with such other forces as to the distribution of the payment made by the Department for such work. No additional payment therefor will be made by the Department by reason of the performance of the work by a subcontractor or other forces.

On all force account work, the plan of work to be followed, the equipment to be used, and the amount and class of labor to be employed shall be determined by the Engineer.

(a) Specialized Work:

Whenever the Contractor is required to perform minor, originally unanticipated work of a specialized nature (electrical, plumbing, landscaping, etc.), for which he is not properly equipped, he may upon approval of the Engineer have the work performed by a local firm or specialist who is proficient in the type of work to be performed.

Payment for this work shall be the Contractor's actual cost as evidenced by copies of invoices from the person or firm who performed the work. To the Contractor's actual cost shall be added the sum of ten (10) percent for the Contractor's profit and overhead with no further compensation therefor.

(b) Owner-Operators:

Whenever the Contractor is authorized by the Engineer to utilize bona fide owner-operators on force account work, payment shall be at the lump sum rate shown on the Contractor's payrolls which includes wages and equipment rental. To this lump sum rate shall be added the sum of ten (10) percent for the Contractor's profit and overhead with no further compensation therefor.

Work specified and performed on a force account basis shall be paid for as follows:

1. Labor. The Contractor will be paid the cost of labor for the workmen (including foremen when authorized by the Engineer) used in the actual and direct performance of the work. The cost of labor, whether the employer is the Contractor, subcontractor, or other forces, will be the sum of the following:

a. Actual Wages Plus Vacation Pay. The actual wages paid, plus vacation pay, which shall not include any employer payments to, or on behalf of, workmen for health and welfare, pension, and similar purposes.

b. Labor Surcharge. To the actual wages, plus vacation pay, as defined above, will be added a labor surcharge set forth in the special provisions, which labor surcharge shall constitute full compensation for all payments imposed by State and Federal laws.

c. Fringe Benefits. To the sum of paragraph (a), "Actual Wages Plus Vacation Pay," and paragraph 1 above, shall be added all other payments made to or on behalf of the workmen as required by collective bargaining agreements, or as otherwise provided in the special provisions.

d. Subsistence and Travel Allowance. Subsistence and travel allowance paid to such workmen as required by collective bargaining agreements.

To the total of the direct costs computed above, there will be added a markup of twenty-five (25) percent.

2. Materials. For materials accepted by the Engineer and used in the work the Contractor shall receive the actual cost of such materials, to which cost shall be added an amount equal to twenty (20) percent of the sum thereof.

3. Equipment. For any machinery or special equipment, the use of which has been authorized by the Engineer, the Contractor will be paid for the use of equipment in the manner hereinafter specified, regardless of ownership and any rental or other agreement, if such may exist, for the use of such equipment entered into by the Contractor.

Rental rates will be determined as follows:

a. The base rates shall be those established in publications and revisions thereto entitled "Rental Rate Blue Book for Construction Equipment" or the "Rental Rate Blue Book for Older Construction Equipment" as published by Dataquest, 1290 Ridder Park Drive, San Jose, CA 95131, Phone (408) 971-9000.

The hourly rate to be paid shall be the sum of the weekly blue book rate divided by forty (40) plus the estimated operating cost per hour shown therein.

b. Attachments (e.g., tractor with ripper and dozer or tractor with loader and backhoe) will be included in the hourly rental rate only when deemed essential to the work as determined by the Engineer. When multiple attachments are approved for use and are being used interchangeably, the attachment having the higher rental rate shall be the only one included for payment.

c. The total established rental rate per hour shall be rounded to the nearest ten (10) cents.

d. Rental rates shall not be adjusted for regional differences.

e. No compensation shall be allowed for shop tools having a daily rental rate of less than ten (10) dollars as set forth in section 18 of the "Rental Rate Blue Book for Construction Equipment."

A copy of the "Rental Rate Blue Book for Construction Equipment" is available for inspection by interested parties at the office of the Resident Engineer and in the Headquarters Construction Division Office in Carson City. Additionally, a copy of the "Rental Rate Blue Book for Older Construction Equipment" is available for inspection in the Headquarters Construction

Division Office. Interested parties desiring to purchase these publications should direct their inquiries directly to Dataquest at the address stated above.

If it is deemed necessary by the Engineer to use equipment not listed in the aforementioned publications, a suitable rental rate for such equipment will be established by the Engineer. The Contractor may furnish any cost data which might assist the Engineer in the establishment of such rental rate. Except as provided in subsection 109.01, "Measurement of Quantities," payment will be made for the actual time that such equipment is in operation on the work, or for standby time, to which rental sum twenty (20) percent shall be added.

The rental rates paid as above provided shall include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance, and all incidentals.

4. Supervision and Tools. No additional allowance shall be made for general superintendents, the use of small tools, or other costs for which no specified allowance is herein provided.

5. Records. At the end of each day the Contractor's representative and the Engineer shall compare records of the cost of the work to be done as ordered on a force account basis.

6. Documentation.

a. Labor. No payment will be made for labor performed on force account work until the Contractor has furnished to the Engineer certified copies of payrolls covering that period when the force account work was performed. The payrolls shall indicate names, classification, dates, daily hours, and hourly rate for each workman.

b. Materials. Copies of the suppliers' invoices, including transportation charges, shall be furnished the Engineer. However, if materials used on the force account work are not specifically purchased for such work, but are taken from the Contractor's stock, then in lieu of the invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from his stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

109.04 Eliminated Items. Should any items contained in the proposal be found unnecessary for the proper completion of the work, the Engineer may, upon written order to the Contractor, eliminate such items from the contract, and such action shall in no way invalidate the contract. When a Contractor is notified of the elimination of items, he will be reimbursed for actual work done and all costs incurred, including mobilization of materials prior to said notification.

109.05 Common Carrier Rate Adjustments. It is understood and agreed that the accepted proposal for the work is based on common carrier rates on file with the Interstate Commerce Commission, or with a corresponding intrastate commission or body and in effect on the date of opening of bids. Payments to the Contractor will be adjusted to compensate for increases and decreases in cost due to changes in common carrier rates becoming effective after the date of opening of proposals, and before the date stipulated for the

completion of the work, including authorized extensions of time. Adjustments shall be limited to rates on file with the Interstate Commerce Commission only, to materials entering into and forming a part of the project, and to an amount determined as follows: Adjustments shall be the product of the increase or decrease of said common carrier rates multiplied by the net quantity of material shipped at the new rates to the work, all as shown by the receipted common carrier bill. No adjustments will be allowed for changes in rates allowed by intrastate commissions or bodies.

109.06 Partial Payment. Partial payments will be made once each month as the work satisfactorily progresses. The progress estimates shall be based upon material in place, or on the jobsite and invoiced, and labor expended thereon. The total amount of the partial payment ascertained as allowable for payment shall be paid each month until such time as a total of eighty-five (85) percent of the contract price has been paid. The contract price will be adjusted upward or downward in accordance with approved changes throughout the life of the contract. Once eighty-five (85) percent of the adjusted contract price has been paid, the Department will withhold retent in the amount of five (5) percent of said adjusted contract price or fifty thousand ($50,000) dollars, whichever is less, until the entire contract is completed satisfactorily and accepted by the Director. If the work in progress is being performed on a satisfactory basis, the Director may reduce the percentage retained if he finds that sufficient reasons exist for additional payment and has obtained written approval from every surety furnishing bonds for the work. Any remaining money must be retained until the entire contract is completed satisfactorily and accepted by the Director.

Control of retent funds under the contract:

The Contractor is entitled to exercise the rights of deposit granted under NRS 408.383 of qualified securities of a market value equal to the funds held by the Department under the retent under the contract.

As an alternative to the above, if the Contractor so requests, the Department agrees to deposit the funds accrued in the retent under the contract in a Nevada bank or other approved financial institution designated by the Contractor. The funds will be deposited in a "time deposit open account" in an account identified as Nevada Highway Department Retent Funds of Contract No. ..... (applicable contract number).

The Department shall remain in control of the deposit until final acceptance of the project with all right to the retent as provided in the general provisions. The interest accruing to the deposit shall be for the benefit of the Contractor who may leave the interest on deposit in the account or be entitled to withdraw the interest only from the account. The interest accruing in the above-referenced deposit shall be income to the Contractor for income tax purposes.

Administrative charges, if any, in connection with a requested deposit of the retent or a deposit by the Contractor of securities as provided by NRS 408.383 shall be borne by the Contractor and paid out of the interest accruing on the deposit or on the securities deposited.

The above deposit will be closed out and forwarded to the Contractor when the Department has accepted the project and has determined that the contract should be finalized and final payment made.

No estimate or payments shall be required to be made, when, in the judgment of the Engineer, the work is not proceeding in accordance with the provisions of the contract.

No estimate or payment shall be construed to be an acceptance of any defective work or improper material.

The cost of materials conforming to the plans and specifications (''materials'' being those which are required to be contained and incorporated in a finished contract bid item) and not at the time incorporated in the work, may also be included in the estimate for partial payment. In no case shall the amount paid exceed the amount bid for a particular bid item.

Partial payment will be made on manufactured materials which have been purchased and stockpiled for use on the project provided said materials are stockpiled within the boundaries of the State of Nevada and subject to the following limitations:

(a) Stockpiled separate and apart from materials that are not to be used on this project.

(b) Tagged or marked in such a manner that they are easily identified as materials for this project.

(c) Kept safe from theft and vandalism.

(d) Accessible during normal working hours to allow periodic inspections by representatives of the State.

(e) Removed and utilized on this project only.

Partial payment will also be made for stockpiled materials for Item No. 506.0110, ''Structural Steel,'' stockpiled either within or outside the State of Nevada at the supplier's or Contractor's storage site. Partial payments for structural steel shall be subject to the preceding conditions in paragraphs (a) through (e) and in addition thereto, the following conditions in paragraphs (f) through (h):

(f) Steel plates shall be rolled to the proper dimensions for a particular girder.

(g) Invoices for labor and materials shall accompany the request for partial payment.

(h) All stockpiled plates shall be checked and verified against invoices by the on-site State inspector.

Partial payments will be made on ''Class *..... Concrete (major)'' and ''Class *..... Concrete, Modified (major),'' for falsework, forming and for labor and materials involved, up to but not to exceed seventy (70) percent of the plan quantity for the concrete item being formed. The Engineer may allow up to thirty-five (35) percent of the plan quantity for the applicable concrete item as the falsework or earth shoring progresses. The Engineer may also allow up to an additional thirty-five (35) percent as the deck forming progresses.

In cases where there isn't any falsework or minimal falsework, the Engineer may allow up to seventy (70) percent of the applicable major concrete item as the forming progresses.

*Class(es) to be as indicated in the estimate and proposal.

Partial payments may be made on ''local materials'' meeting the requirements hereinafter outlined:

5

(a) Materials shall be stockpiled on or in the vicinity of the proper project (generally on land adjacent to the project).

(b) All materials shall be stored in an approved manner in areas where damage from flood waters is not likely to occur. If at any time stored materials are lost or become damaged by floods or in any other manner, the Contractor will be responsible for the repair and replacement of such damaged materials. If payment has been made prior to such damage, the amount so allowed, or a proportionate part thereof, shall be deducted from the next partial payment and withheld until satisfactory repairs or replacements have been made.

(c) Partial payments will be made only on materials that conform to plans and specifications (not to be construed as final acceptance). The quantities will be determined by volume measurement and converted to tons if the contract unit price of the item is in tons. In the case of "Portland cement concrete pavement," the unit price will be converted to square yards per ton. However, partial payments shall not exceed the actual cost to the Contractor to provide the material.

(d) No payment shall be made on any commercial stockpile or on any stockpile from which materials are being used for any purpose whatsoever other than incorporation into the project.

(e) Partial payment shall be made at the contract unit price for the percentage of material allowed. The quantity in stockpile, or windrow, to be considered shall not exceed that required for the project.

The Contractor shall be responsible for any material that has been included in the estimate for payment.

(f) Schedule of Payments.

1. Not more than forty (40) percent of the quantity of Class A and Class B aggregate base courses in the stockpile may be allowed. Not more than eighty-five (85) percent of the quantity of cement treated base roadmix in the processed windrow on the roadway may be allowed.

2. Not more than thirty (30) percent of the quantity of cement treated base aggregate (roadmix or plantmix) in the stockpile may be allowed. Not more than eighty-five (85) percent of the quantity of cement treated base roadmix in the processed windrow on the roadway (prior to adding cement) may be allowed.

3. Not more than twenty (20) percent of the quantity of plantmix base, surface, or open-graded surface aggregate in the stockpile may be allowed.

4. Not more than eighty-five (85) percent of the quantity of roadmix bituminous surface aggregate in the processed windrow on the roadway (prior to adding bituminous material) may be allowed.

5. Not more than forty (40) percent of the quantity of screenings in the stockpile may be allowed.

6. Not more than eighty-five (85) percent of the quantity of selected material base conforming to all the requirements, in windrow, may be allowed.

If materials are not specifically purchased for the work, but are taken from the Contractor's stock, then in lieu of invoices, there shall be submitted to the Engineer, statements accompanied by an affidavit of the Contractor, certifying such materials were taken from his stock and the price and transportation claimed represent the actual cost to the Contractor.

No partial payment will be made on living or perishable plant materials until planted.

Unless otherwise specified, all material and work covered by partial payments shall thereupon become the property of the State, but this provision shall not be construed as relieving the Contractor from the sole responsibility for all materials and work upon which payments have been made or the restoration of any damaged work, or as a waiver of the right of the Department to require the fulfillment of all terms of the contract.

Partial payments will be made on the items of "construction signs" and "barricades" as hereinafter outlined:

(a) Watering. No payment, partial or otherwise, will be made for the item of "watering." Full compensation for developing and maintaining an adequate water supply will be considered included in other items of work.

(b) Construction Signs. When construction signs are placed on the project, in accordance with the plans and specifications, fifty (50) percent of the contract price per square foot of acceptable signs in place will be paid for on the next monthly estimate after placing. The remaining percent will be prorated in accordance with job progress. However, if signing becomes inadequate for job requirements, in the opinion of the Engineer, an adjustment downward shall be made on the first monthly estimate following such inadequacy.

Once the inadequacies or deficiencies are corrected and the Engineer again resumes normal payment, prorated with progress, the amount of progress accomplished during the delinquent period will be permanently excluded from the factor used by the Engineer to determine the payment due.

(c) Barricades. When barricades are placed on the project in accordance with the plans and specifications, fifty (50) percent of the contract bid price per linear foot or per each (as the case may be) of the barricades thus in use will be paid for on the next monthly estimate after placing. The remaining percent will be prorated in accordance with job progress. However, if barricades become inadequate for job requirements, in the opinion of the Engineer, an adjustment downward shall be made on the first monthly estimate following such inadequacy.

Partial payments will be made on the items of fence, guardrail, bridge rail, mobilization, signal systems and/or highway lighting systems, cattle guards, and trenching for irrigation systems as hereinafter noted provided that materials and equipment are supplied to the satisfaction of the Engineer:

(a) Fence. When fencing material is stored on the project, invoice prices may be paid as outlined herein. When the fence posts have been placed, sixty (60) percent of the partially completed fence will be eligible for payment at the contract unit bid price. The remaining forty (40) percent will be eligible for payment when the item is complete.

The cost of wire and posts conforming to the plans and specifications which are required to be contained and incorporated in a finished contract bid item delivered to the project and not at the time incorporated in the work, may be included in the estimate for partial payment.

(b) Guardrail and Bridge Rail. When guardrail and bridge rail materials are stored on the project in accordance with this subsection, invoice prices for such materials may be paid.

When posts for guardrail or reconstruct guardrail are complete in place, fifty (50) percent of the contract bid price per foot will be eligible for payment.

The remaining portion of the contract unit bid price will be eligible for payment when the item is complete.

(c) Mobilization. Partial payments will be made in accordance with the following schedule:

1. When five (5) percent of the original contract amount is earned from other bid items, fifty (50) percent of the amount bid for mobilization, or five (5) percent of the original contract amount, whichever is less, will be paid.

2. When ten (10) percent of the original contract amount is earned from other bid items, one hundred (100) percent of the amount bid for mobilization, or ten (10) percent of the original contract amount, whichever is less, will be paid.

3. Upon completion of all work on the project, payment of any amount bid for mobilization in excess of ten (10) percent of the original contract amount will be paid.

4. The total sum of all payments shall not exceed the original contract amount bid for mobilization, regardless of the fact that the Contractor may have, for any reason, shut down his work on the project or moved equipment away from the project and then back again.

(d) Signal Systems and/or Highway Lighting Systems. The cost of materials for luminaires, poles and mast arms, controllers and cabinets, signal heads and detector units, conforming to the plans and specifications (''materials'' being those which are required to be contained and incorporated in a finished contract bid item), delivered to the project and not at the time incorporated in the work, may also be included in the estimate for partial payment. Other items will not be included for partial payment until incorporated in the work.

(e) Cattle Guards. The first monthly estimate after the cattle guard has been completed, but the wings not yet installed, will show this item ninety (90) percent complete.

The remaining ten (10) percent shall be eligible for payment on the first monthly estimate after the wings have been installed.

(f) Trenching for Irrigation Systems. When trenches for irrigation pipe distribution lines have been excavated and the pipe has been placed but not backfilled, seventy-five (75) percent of the partially completed irrigation pipe will be eligible for payment on the next monthly estimate at the contract unit price. Payment will be based on that length of the pipe partially complete.

The remaining twenty-five (25) percent will be eligible for payment on the first monthly estimate following complete installation of the pipe.

109.07 Acceptance and Final Payment. When the final inspection and final acceptance have been duly made by the Engineer as provided in subsection 105.16, ''Final Acceptance,'' and subject to the terms of subsection 108.09, ''Failure to Complete the Work on Time,'' the Engineer shall prepare the final estimate of quantities of the various classes of work performed under the contract. The Contractor shall examine such estimate and notify the Engineer in writing of his agreement or file a specific claim covering disputed

quantities. Failure on the part of the Contractor to so notify the Engineer or file a claim within a period of thirty (30) days after receipt of the estimate shall be construed to signify the Contractor's agreement to the quantities as set forth, and he shall have no further claim against the Department, except as indicated in the final estimate of quantities. Except as hereinafter provided, final payment shall be due and payable at the expiration of not less than thirty (30) calendar days nor more than sixty (60) calendar days from the date of final acceptance.

Regardless of the sixty (60) day limitation provided above, final payment of the work by the Engineer shall be withheld until the Contractor furnishes all certificates, guaranties, releases, affidavits, and any other documentation required by these specifications and the special provisions.

SECTION 110

WAGES AND CONDITIONS OF EMPLOYMENT

110.01 Description. The provisions pertaining to wages and conditions of employment shall apply to all work performed (on the contract) by the Contractor with his own organization and with the assistance of workmen under his immediate superintendence, and to all work performed on the contract by subcontractors.

The laborers shall have access to the pertinent minimum wage schedules at all times. The Contractor shall provide and erect a weatherproof bulletin board at the jobsite and post all minimum wage schedules and other required information thereon. The weatherproof bulletin board shall be so constructed that the material thereon is adequately protected from the elements. The cost of providing and erecting the weatherproof bulletin board shall not be measured or paid for directly but shall be considered as included in the contract bid price paid for other items of work.

It is a condition of the contract, and shall be made a condition of each subcontract entered into pursuant to the contract, that the Contractor and any subcontractor shall not require any laborer or mechanic employed in performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health or safety as determined under construction safety and health standards (Title 29, Code of Federal Regulations, Part 1926—published in the Federal Register on December 16, 1972, and subsequent revisions) promulgated by the United States Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (83 Stat. 96).

110.02 Laws Cited. The Contractor's attention is directed particularly to the provisions and requirements of the following:

(a) Wages, Hours, and Employment on Public Works—Nevada Revised Statutes, Chapter 338.

(b) State Industrial Insurance System Act—Nevada Revised Statutes, Chapter 616. (The Contractor will be required to furnish a certificate from the State Industrial Insurance System as evidence that he has paid all the premiums and percentages as required by the act, and said certificate shall be furnished the Engineer before any work is commenced.)

(c) Unemployment Compensation Law—Nevada Revised Statutes, Chapter 612.

(d) Highway Camp Sanitation—Nevada Revised Statutes, Secs. 444.130, 444.200, and 444.210.

(e) Highways and Roads Law—Nevada Revised Statutes, Chapter 408.

(f) Fair Labor Standards Act of 1938 (52 Stat. 1060).

(g) Work Hours Act of 1962.

(h) Any and all legislation, rules, or regulations promulgated by the State of Nevada, or its agencies, covering any work performed by the Contractor.

(i) Fraudulent and Discriminatory Employment Practices—Nevada Revised Statutes, Chapter 613.

DIVISION II

CONSTRUCTION DETAILS

SECTION 201

CLEARING AND GRUBBING

DESCRIPTION

201.01.01 General. This work shall consist of urban or rural clearing and grubbing as hereinafter set forth.

The work contemplated under this section shall be understood to include one or more of the following categories:

(a) Removal and disposal of all vegetation and trash within construction limits.

(b) Removal and disposal of all natural or man-made objects and trash within the right of way limits of the project, except such objects as are designated to remain or be removed in accordance with other sections of these specifications.

The Contractor shall be fully responsible for, and shall bear all expenses in connection with the protection from injury or defacement of all vegetation and objects designated to remain undisturbed or which by reasonable and prudent approach, should remain undisturbed as determined by the Engineer.

CONSTRUCTION

201.03.01 General. The Engineer shall designate all areas to be cleared, and all things that are to remain undisturbed.

201.03.02 Areas to be Cleared. Normally, the area to be cleared and grubbed shall be the area within construction limits. On a given project, the area to be cleared may, however, be the entire right of way if the area is littered with trash.

If the project is located in an area subject to unauthorized refuse disposal, prospective bidders shall determine for themselves the extent and cost of removal and disposal of such materials and include those costs in appropriate bid items. If, in the opinion of the Engineer, unauthorized dumping and disposal of materials occurs subsequent to award of contract, and such material must be removed to enable proper execution and completion of the work, said removal shall be paid for in accordance with subsection 109.03, "Extra and Force Account Work."

The foregoing shall not operate as an instrument to nullify the Contractor's responsibility as set forth in subsection 102.05, "Examination of Plans, Specifications, Contract Documents, and Site of Work."

201.03.03 Clearing and Grubbing. All surface objects and all trees, stumps, roots, and other protruding obstructions, designated for removal, shall be cleared or grubbed or both. Unless otherwise specified, the Contractor may leave stumps and nonperishable solid objects provided they do not extend more than six (6) inches above the ground line or low water level, and are a minimum of three (3) feet below subgrade or embankment slope.

The Engineer may permit sound stumps that are cut off flush with ground level (or when flush with ground level is not possible, as determined by the Engineer, cut off not more than six (6) inches above the ground) to be left outside of the construction limits of cut and embankment areas, except in the area to be rounded at the top of backslopes where stumps are to be cut off flush with or below the surface of the final slope line.

Where feasible, trees shall be felled toward the center of the area to be cleared. Where trees cannot be felled without danger to traffic or injury to other trees, structures, or property, they shall be cut in sections from the top down.

The Contractor may dispose of brush by placing it beneath fill slopes of roadway embankments provided the embankment height is three (3) feet or greater and subject to the following additional requirements:

(a) Beneath embankments three (3) to five (5) feet in height:

The brush shall be buried in a trench. The limits of the trench may extend inward from the toe of the embankment slope to a point not to exceed sixteen (16) feet or to the subgrade shoulder line, whichever is less. In any case, brush shall not be buried beneath the subgrade between the subgrade shoulders of the embankment. The depth of the brush in the trench shall not exceed one and one-half (1½) feet.

(b) Beneath embankments five (5) feet or greater in height:

Brush may be windrowed and buried beneath embankment slopes. The limits of the brush windrow may extend inward from the toe of the embankment slope to the subgrade shoulder line. In any case, brush shall not be buried beneath the subgrade between the subgrade shoulders of the embankment. The height of the windrowed brush shall not exceed one and one-half (1½) feet.

In any event, when brush is buried beneath the roadway embankment slopes, there shall be not less than one (1) foot of earth cover over the brush when the embankment is completed.

Existing borrow pits and depressions within the right of way, except major waterways, may be filled with brush and covered with a minimum of four (4) inches of earth.

Burning will not be permitted as a method of disposal.

When permitted by the Engineer, materials, debris, and perishable materials may be removed from the right of way and disposed of at locations off the project outside the limits of view from the project with the written permission of the property owner on whose property the materials and debris are placed. The Contractor shall make all necessary arrangements with property owners for obtaining suitable disposal locations and the cost involved shall be included in the unit price bid. Attention is directed to subsection 107.14, "Disposal of Material Outside Highway Right of Way."

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material. If within the roadway prism the material shall be compacted in accordance with subsections 203.03.17, "Compaction, Dirt Embankment" or 203.03.18, "Compaction, Rock Embankment." Payment for backfilling and compacting will be considered subsidiary to other items of the work and no further compensation will be made therefor.

All merchantable timber in the clearing area shall become the property of the Contractor unless otherwise provided. Timber may be stored or decked within the right of way only in areas approved by the Engineer and must be removed prior to final acceptance of the project.

Trees and shrubs that are to remain in place shall have low hanging and unsound or unsightly branches removed as directed. Branches of trees extending over the roadbed shall be trimmed to give a clear height of twenty (20) feet above the roadbed surface. All trimming shall be done in accordance with good tree surgery practices. Paint shall be required for cut or scarred surfaces of trees or shrubs selected for retention. The material shall be an approved asphaltum based paint prepared especially for tree surgery.

Scalping shall include the removal of material such as brush, roots, sod, grass, residue of agricultural crops, sawdust, and decayed vegetable matter from the surface of the ground.

Unless otherwise permitted by the Engineer, the Contractor shall scalp areas where excavation or embankment is to be made, except that mowed sod need not be removed where the embankment to be constructed is four (4) feet or more in height to subgrade elevation.

201.03.04 Rural Clearing. This work shall consist of removing and disposing of all natural and man-made objects that are not compatible with completion of the project unless otherwise provided. All work shall be accomplished in accordance with this section of these specifications.

201.03.05 Urban Clearing. Urban clearing shall consist of removing and disposing of all unsightly organic or man-made objects within right of way limits of the project. At the discretion of the Engineer, certain items, such as broken concrete or asphaltic paving material, may remain in place provided they are covered by a minimum of three (3) feet of embankment in the completed work. The material to be removed shall include but not be limited to rocks, brush, other vegetation, buildings, appurtenances such as lighting and signing, foundations, concrete slabs, tanks, fences, and trash.

It is the intent of these provisions that upon completion of the work specified in this section, the area within the right of way limits shall present a neat and pleasing appearance and that such area shall be free of all objectionable natural objects such as rocks, trees, brush, or other vegetation, as well as man-made objects and that all building sites shall be graded to blend with the natural ground and all streets, foundations, and other unnecessary man-made objects be eradicated.

The Contractor shall be required to leave the ground in a condition that it will drain freely and no water pools shall be formed at any point within the

area in which operations have been conducted or adjacent thereto. The duty imposed on the Contractor by this provision shall extend to all areas within the right of way whether or not the plans require the Contractor to perform work in such areas. The intent of this provision is that the land be left in a condition suitable for an urban neighborhood.

METHOD OF MEASUREMENT

201.04.01 Measurement. Measurement will be made by one or more of the following methods:

Urban and/or rural clearing or clearing and grubbing shall be measured for payment on a lump sum, force account, or acre basis in accordance with the unit of measurement specified in the proposal.

When trees are specified to be removed on an individual basis according to trunk diameter, the diameter will be measured at a height of twenty-four (24) inches above ground line. Any growth less than six (6) inches in diameter at that point shall be classified as brush and shall not be included in the individual measurement of removal of trees.

Removal of stumps will be measured on an individual count basis.

When removal of individual items does not appear in the proposal, such work shall be considered included in the lump sum, force account, or acre price paid for urban and/or rural clearing or clearing and grubbing or, in the absence of any item in the proposal, as incidental work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

PAYMENT

201.05.01 Payment. The accepted quantity of rural and/or urban clearing or clearing and grubbing, removal of trees, or removal of stumps, measured as provided in subsection 201.04.01, "Measurement," will be paid for under the appropriate contract unit price bid in the proposal, which price shall be considered full compensation for removing, hauling, disposing, filling, and compacting of all voids left by removals, trimming, grading, and dressing the area to drain, and all other work necessary to leave the area in a clean, presentable condition, and no further compensation shall be allowed therefor.

When the proposal does not contain an item of urban and/or rural clearing, clearing and grubbing, removal of trees, or removal of stumps, such work shall not be measured or paid for directly but the cost thereof shall be considered included in the contract unit price bid for other items of work and no additional compensation shall be allowed therefor, except as provided in subsection 201.03.02, "Areas to be Cleared," as it pertains to unauthorized dumping and disposal of materials subsequent to award of contract.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Urban Clearing	Lump Sum, Force Account, or Acre
Rural Clearing	Lump Sum, Force Account, or Acre
Urban and/or Rural Clearing	Lump Sum, Force Account, or Acre
Clearing and Grubbing	Lump Sum, Force Account, or Acre
Removal of Trees (size)	Each
Removal of Stumps	Each

SECTION 202

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

DESCRIPTION

202.01.01 General. This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings, fences, guardrail, structures, old pavement, abandoned pipe lines, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the contract. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes, and pits.

CONSTRUCTION

202.03.01 General. The Contractor shall raze, remove, and dispose of all buildings and foundations, structures, guardrail, object markers and guide posts, fences, and other obstructions, any portions of which are on the right of way, except utilities and those for which other provisions have been made for removal. All designated salvable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored by the Contractor at specified places within the project limits. Unusable perishable material shall be destroyed. Nonperishable material may be disposed of in accordance with subsection 107.14, "Disposal of Material Outside Highway Right of Way." Basements or cavities left by structure removal shall be filled to the level of the surrounding ground and, if within the prism of construction, shall be compacted in accordance with subsections 203.03.17, "Compaction, Dirt Embankment," or 203.03.18, "Compaction, Rock Embankment."

202.03.02 Removal. Bridges, culverts, and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

All operations necessary for the removal of any existing structure which might endanger the new construction shall be completed prior to the construction of the new work. No equipment or devices shall be used which might damage structures, facilities, or properties which are to be preserved and retained.

Unless otherwise directed, the substructures of existing structures shall be removed down to the natural stream bottom and those parts outside of the stream shall be removed down one (1) foot below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work.

In removing concrete or bituminous pavement, curb, curb and gutter, sidewalk, and similar structures, where portions of the existing structures are to be left in the surface of the finished work, the structure shall be removed to an existing joint, or cut and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections in the new work.

In removing manholes, catch basins, and inlets, any live sewers connected to them shall be rebuilt and properly reconnected and a satisfactory bypass service shall be maintained during such construction operations. When abandoning manholes, catch basins, and inlets, they shall be thoroughly cleaned and existing pipe connections shall be plugged with concrete of the class and grade specified for structures. The portions of the structures shall then be removed to the required elevations.

Removal of painted traffic lines shall be accomplished as directed by the Engineer by using equipment that uses a combination of chemical and high pressure water or by other means approved by the Engineer. Care shall be exercised to prevent damage to the pavement surface.

In removing bituminous pavement by the cold milling process, the work shall be accomplished with a machine designed to remove, profile, and texture the remaining surface of the pavement in one (1) operation. The milling machine shall consist of a rotating powered mandel drum studded with conical tungsten carbide tipped bits and shall produce a reasonable smooth textured surface satisfactory to the Engineer, and shall be equipped with an effective means for controlling dust and other particulate matter created by the cutting action.

The machine shall be capable of accurately establishing profile grades (within plus or minus one-quarter (1/4) inch) by referencing from the existing pavement or concrete bridge decks or from an independent grade control and shall have a positive means for controlling cross slope elevations. When referencing from the existing pavement or concrete surface on bridge decks, a twenty (20) foot minimum averaging ski shall be used. At the option of the Engineer, use of the averaging ski may be discontinued when pavement or concrete conditions so warrant.

The location and depth of removal of bituminous pavement by the cold milling process shall be as indicated on the plans unless otherwise directed.

202.03.03 Extensions. Where existing culverts and bridges are to be extended or otherwise incorporated in the new work, only such part or parts of the existing structure shall be removed as is necessary to provide a proper connection to the new work. The connecting edges shall be cut, shaped, and trimmed to the required lines and grades without weakening or damaging the part of the structure to be retained. Reinforcing bars which are to be left in place so as to project into the new work as dowels or ties, shall not be injured during removal of concrete.

202.03.04 Closing Culverts. Existing culverts within construction limits, the top of which are five (5) feet or more below finished roadway grade, shall be abandoned and closed unless otherwise noted on the plans. The headwalls of such culverts, or any part of the structure that is within three (3)

feet of the finished grade line shall be removed. The ends of the culvert shall be completely filled with satisfactory soil for a distance of at least two (2) feet, plus the height of the opening of the structure.

202.03.05 Salvage. When specified, gravel, roadmix, or plantmix surface suitable for reuse shall be removed to the depth required and surfacing so removed shall be carefully salvaged and placed in compact stockpiles at locations approved by the Engineer. Care shall be exercised to prevent contamination of stockpiled material. Any remaining unsuitable material shall be scarified and incorporated in embankment as set forth in Section 203, "Excavation and Embankment."

Fences and gates designated for reuse shall be removed in such a manner that so far as practicable all material can be salvaged. Wire shall be carefully removed from the posts and rolled in rolls of such size that can be conveniently handled. Posts shall be removed by methods that will keep breakage to a minimum.

Guardrail, object markers, and guide posts designated for reuse shall be removed in such a manner that so far as practicable all material can be salvaged. Bolts, supports, and other hardware shall be removed from all rails, plates, and posts and all parts shall be sorted and stored at the locations specified. Rails, plates, and posts shall be properly stacked and miscellaneous hardware shall be stacked or boxed and reasonable care exercised in handling, storage, and preservation of materials as will insure the maximum salvage value for the entire operation. Attention is directed to Sections 618, "Guardrail," and 619, "Object Markers and Guide Posts."

When specified for salvage, structural steel removed from old structures shall be stored in a neat and presentable manner on blocking and at locations suitable for loading. Structures or portions thereof which are specified for reerection shall be stored in separate piles.

When relay culvert pipe is required, the Contractor shall remove the pipe in such a manner as not to damage the material in any way. If no particular pipe is noted for relay, the Contractor shall salvage and clean sufficient amount of the better grade of pipe to satisfy the relay pipe item. Attention is directed to subsection 604.03.04, "Relay Culvert Pipe."

Timber or piling from all structures designated to be salvaged shall have all nails and bolts removed therefrom and shall be stored in neat piles at locations suitable for loading.

202.03.06 Disposing of Materials. Unless otherwise provided, excavated material shall be used in backfilling excavations made in removing the structure, in constructing embankment, or otherwise disposed of in a manner satisfactory to the Engineer.

Any concrete or masonry which cannot be placed in embankments, shall be disposed of in such a manner as to prevent damage to property or the creation of unsightly conditions. The material shall not be placed where it will obstruct any drainage course.

When concrete or masonry is placed in embankments, it shall be placed in accordance with subsection 203.03.15, "Embankment Material."

Any material removed and not designated for salvage shall become the

property of the Contractor and shall be removed from the project prior to completion thereof. Attention is directed to subsection 107.14, "Disposal of Material Outside Highway Right of Way."

METHOD OF MEASUREMENT

202.04.01 Measurement. When the contract stipulates that payment will be made for removal of structures and obstructions on a lump sum basis, the pay item will include removal of all structures and obstructions encountered within the right of way in accordance with the provisions of this section. Where the proposal stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the contract.

The length of pipe removed will be measured in linear feet, by measuring in place prior to removal.

Removal of painted traffic line from all types of surfacing shall be measured by payment on a linear foot basis regardless of line width for the actual linear footage of line removed. When more than one line is removed, each line shall be measured separately. Gaps in spacing of lines will be included in the linear foot measurement.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

202.05.01 Payment. The accepted quantities of removal of structures and obstructions will be paid for at the contract lump sum price bid, which price shall be full compensation for removing and disposing of the obstructions in accordance with the contract, including excavation, and subsequent backfill.

Specific obstruction items stipulated for removal and disposal under unit price pay items will be paid for at the contract unit price bid per unit specified in the proposal—which price shall be full compensation for removal and disposal of such items, excavation, and subsequent backfill incidental to their removal. The price shall also include salvage of materials removed, their custody, preservation, storage on the right of way, and disposal as provided herein.

When the proposal does not include any pay item or an appropriate pay item for removal of any structure or obstruction as set forth in this section, such work shall be performed and payment therefor will be considered as subsidiary to other items of work. No additional compensation will be allowed.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Removal of Structures of Obstructions	Lump Sum
Removal of	Each, Linear Feet, Stations, Miles, Square Yards

SECTION 203

EXCAVATION AND EMBANKMENT

DESCRIPTION

203.01.01 General. This work shall consist of grading and excavating the roadway, excavating borrow pits, removing slide material, and excavating ditches and stream channels and satisfactorily disposing of all excavated material and all work necessary for the construction and completion of cuts, embankments, slopes, ditches, dikes, stream channels, approaches, parking areas, intersecting driveways and highways, and subsidiary work. Exceptions are overhaul, slope rounding, or other separately designated pay items of work which are made a part of the contract. All work shall be in reasonably close conformity with the alignment, grades, and cross sections shown on the plans or established by the Engineer.

MATERIALS

203.02.01 Roadway Excavation. Roadway excavation shall consist of all excavation involved in grading and constructing the roadway and appurtenances, irrespective of the nature or type of material encountered, except excavation designated as structure excavation, drainage excavation, channel excavation, and selected borrow when these items are provided as items of work under the contract. Dividing the project into construction stages shall not be construed as separate material classification.

203.02.02 Drainage Excavation. Drainage excavation shall include all excavation in the construction of open ditches less than twelve (12) feet in bottom width, excepting ditches that are part of the roadway prism as shown on the plans. The nature or type of material encountered shall have no bearing on the classification of material.

203.02.03 Channel Excavation. Channel excavation shall include all excavation in the construction of open ditches or stream changes with a bottom width of twelve (12) feet or more with the exception of ditches that are part of the roadway prism as shown on the plans. The nature or type of material encountered shall have no bearing on the classification of material.

203.02.04 Borrow. Borrow shall consist of approved material required for the construction of embankments or for other portions of the work, and shall be obtained from approved sources. The widening of roadway cuts shall be considered as roadway excavation and not as borrow, unless otherwise specified. Borrow will not be classified according to type or character of material encountered in the borrow area unless otherwise required in the special provisions.

203.02.05 Selected Borrow. Selected borrow shall consist of approved material required for the construction of embankments within the required

limits shown on the plans or directed by the Engineer, and shall be obtained from approved sources.

Selected borrow shall conform to the requirements set forth in the special provisions.

CONSTRUCTION

203.03.01 Roadway. All excavation shall be made true to lines and grades staked by the Engineer and shall be so conducted as to avoid removing or loosening any material outside the required slopes. If any material is so disturbed it shall be replaced and thoroughly compacted to the required cross section, unless such replacement is impractical as determined by the Engineer.

The work done under this section shall begin at some definite point or points on the project, and be carried forward in an approximately completed manner. The roadway shall be graded to full cross section width before placing base or surfacing of any type, unless otherwise specified.

Intersecting roads, service highways, ramps, approaches, and driveways shall be graded as shown on the plans or established by the Engineer.

All suitable material removed from the excavation shall be used as far as practicable in the formation of embankments, subgrade, shoulders, slopes, dikes, and backfill for structures, unless otherwise indicated on the plans or disposed of in a manner satisfactory to the Engineer. Excavated material shall not be wasted without permission.

203.03.02 Unsuitable Material. Unsuitable material shall be defined as saturated or unsaturated mixtures of soils or organic matter not suitable for foundation material regardless of moisture content. Material that is unsuitable for planned use, including material below the natural ground surface in embankment areas, shall be excavated and disposed of in a manner approved by the Engineer or as specified in the contract documents.

When unsuitable material is removed and disposed of, the resulting space shall be filled with material suitable for the planned use. Such suitable material shall be placed and compacted in layers as hereinafter specified under embankment.

Disposal of material outside the right of way shall be in accordance with subsection 107.14, "Disposal of Material Outside Highway Right of Way."

203.03.03 Blasting. Any material outside the authorized cross section on the backslopes which may be shattered or loosened because of blasting shall be removed by the Contractor at his expense. Shattered or loosened material below the bottom limits of required excavation shall be uniformly distributed and compacted or otherwise disposed of in a manner satisfactory to the Engineer. The Contractor shall discontinue any method of blasting which leads to overshooting or is dangerous to the public or destructive to property or to natural features.

The use of coyote holes in blasting is prohibited.

Attention is directed to subsection 107.10, "Explosives."

203.03.04 Rock Cuts. In excavating side hill rock cuts and rock cliffs,

the Contractor shall exercise care and use precautionary methods so as not to break down, loosen, or otherwise damage supporting rock below the bottom limits of required excavation. In general, such cuts shall be worked from the top of lifts of such height that will not damage the bench of rock below the bottom limits of required excavation. The Contractor shall be responsible for the methods used, and for any damages to the roadbed resulting from his operations.

The slope of all rock cuts shall be scaled and dressed to a safe, stable condition by removing all loose spalls and rock not firmly keyed to the rock slope. Overhanging rock shall be removed when, in the opinion of the Engineer, it may be a hazard to public use of the roadway.

In solid rock excavation, slopes shall be constructed to the approximate neat lines staked by the Engineer. No rock shall project or overhang more than twelve (12) inches from the true slope.

203.03.05 Overbreak. Overbreak is that portion of material excavated, displaced, or loosened outside and beyond the slopes or grade as staked or reestablished, regardless of whether any such overbreak is due to blasting, the inherent character of any formation encountered, or to any other cause. Slides and slipouts as defined in subsection 203.03.10, "Slides and Slipouts," and that portion of rock subgrade as hereinafter set forth, shall not be considered overbreak. All side slope overbreak as so defined shall be removed by the Contractor and shall be disposed of by the Contractor in the same manner as provided for the surplus under the heading of "surplus material," but at his own expense and without any allowance for overhaul.

Rock removed to a maximum depth of six (6) inches below subgrade will be measured for payment as described in subsection 203.04.01(b), "Overbreak."

203.03.06 Slopes. All excavation and embankment slopes, except in solid rock, shall be trimmed to the lines staked by the Engineer. The degree of smoothness shall be that normally obtained by hand shovel operations.

203.03.07 Widening Cuts. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed and within the limits of the right of way, the Contractor shall do so and compensation therefor will be as set forth in subsection 203.04.01(c), "Widening Cuts."

203.03.08 Surplus Material. Unless otherwise specified in the contract documents, surplus excavated material shall be used to widen embankments uniformly, or to flatten slopes, or at other locations, all in a manner satisfactory to the Engineer. No surplus material shall be disposed of above the grade of the adjacent roadbed nor shall the Contractor waste any material unless approved in writing by the Engineer.

If the quantity of surplus material is specified in the contract documents, such quantity shall be considered approximate only. The Contractor shall satisfy himself that there is sufficient material available for the completion of the embankments within the areas involved before disposing of any indicated

surplus material inside or outside the right of way. Any shortage of material caused by premature disposal of the indicated surplus material by the Contractor shall be replaced by him and no compensation will be allowed the Contractor for such replacement.

203.03.09 Selected Material. When specified in the contract documents, or when selected by the Engineer, suitable selected material encountered in excavation or widening the roadway prism or any other excavation within the highway right of way, or in the excavation or borrow, shall be used for finishing the top portion of the subgrade.

Selected material shall be defined as material which is excavated from one (1) or more of the above sources and which is used for selective purposes.

When practicable, selected material shall be hauled directly from excavation to its final position on the roadbed and compacted in place, and such work shall be paid for at the contract unit price for the excavation item involved and overhaul if applicable, as set forth elsewhere in these specifications, and no additional compensation will be made. Attention is directed to subsection 104.05, "Rights in and Use of Materials Found on the Work."

When the transporting of selected material directly from excavation to its final position on the roadway is impractical, the selected material shall be left in place until it can be placed in final position and no additional compensation will be made because of the delayed excavation. If, however, the conditions are such that the undisturbed selected material will hamper ordinary grading operations or cause unnecessary movements of equipment, the Engineer may order in writing the removal of sufficient selected materials and the stockpiling thereof to enable practical hauling operations. If the excavation and stockpiling of selected material is specified in the contract documents or is ordered by the Engineer the excavation shall be from, and the stockpiling at, locations designated by the Engineer. The selected material shall be removed from the stockpile and placed in final position on the roadbed when approved by the Engineer.

Measurement for payment of selected material stockpiled as above provided will be in accordance with subsection 203.04.01(d), "Selected Material."

203.03.10 Slides and Slipouts. Material outside the planned roadway or ditch slopes which is unstable and constitutes potential slides in the opinion of the Engineer, material from slides which has come into the roadway or ditch, and material which has slipped out of new or old embankments shall be excavated and removed. The material shall be excavated to designated lines or slopes either by benching or in such manner as approved by the Engineer. Such material shall be used in the construction of the embankments or disposed of as approved by the Engineer.

The above provisions shall not be so construed as to relieve the Contractor from the duty of maintaining all slopes true and smooth. Erosion, regardless of amount or extent, caused by the action of the elements which results in damage to work or materials, shall in no case be considered a slide or slipout. Measurement for payment will be in accordance with subsection 203.04.01(f), "Slides and Slipouts."

203.03.11 Drainage. During construction of the roadway, the roadbed shall be maintained in such condition that it will be well drained at all times.

V-type ditches shall be formed to the cross section and dimensions on the plans by means of suitable equipment which will deposit all loose material on the downhill side so that the bottom of the finished ditches shall not be less than two (2) feet six (6) inches below the crest of the loose material piled on the downhill side.

In going from cut to fill, the roadway ditches shall be cut to the right or left before reaching the fill so as to avoid damage to embankments by erosion.

The flat-bottom ditches indicated on the plans, or staked by the Engineer, shall be excavated to the required cross section and grade. Materials so obtained shall be used to construct roadway embankments or dikes or both to form a continuous diversion channel as staked by the Engineer.

203.03.12 Channels. To avoid destruction of natural growth during construction of ditches, channels, or dikes, travel of equipment shall be confined to the construction limits as nearly as practicable. Where ditches, channels, or dikes are nearly parallel to the roadway, turn-arounds shall not be located closer than two hundred (200) feet apart. Attention is directed to subsection 107.12, "Protection and Restoration of Property and Landscape."

Fine grading of channel bottoms will not be required unless paving is specified.

203.03.13 Borrow. A possible source of borrow material may be indicated in the contract documents. If the Contractor desires to use borrow materials from sources other than those described in the contract documents, he shall, at his own expense, acquire the necessary right to take materials and pay all costs involved. All costs of exploring such alternate sources shall be borne by the Contractor. Use of material from these sources will not be permitted until approved in writing by the Engineer.

The successful bidder shall, at the time of execution of the contract, execute an "agreement" for all borrow deposits obtained under an "option and agreement for sale of materials" when said "option" is contained in the special provisions. This agreement shall be executed whether the material is to be used or not.

In case designated borrow deposits fail to contain the necessary quantity of acceptable material, the Contractor shall immediately notify the Engineer in writing. The Engineer shall thereupon investigate, and if his investigation shows that there is not a sufficient quantity of acceptable material, he shall designate an alternate deposit in which to obtain the deficit.

In all borrow pits having undesirable material, including overburden, refuse, organic, and deleterious substances, the material shall be removed and wasted or redistributed, in a manner satisfactory to the Engineer. All costs incurred therefor shall be considered as incidental and subsidiary to the borrow and no further compensation will be made for undesirable materials removed.

Borrow shall not be obtained until all other excavation items are complete to the extent necessary to determine the need for borrow.

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow areas so that cross section elevations and measurements of the ground surface after stripping may be taken, and the borrow materials can be tested before being used. Sufficient time for testing the borrow shall be allowed.

Borrow deposits shall be excavated to regular lines as staked to permit accurate measurement. The dimensions of the borrow deposit will be designated and the Contractor shall not excavate below the depth or outside limits given except with prior approval. The depth of excavation throughout the area of the borrow pits shall be as uniform as practicable and the side slopes shall conform to the requirements of subsection 104.06, "Final Clean Up." Unless otherwise permitted, borrow pits shall be excavated so that they will drain to the nearest natural outlet.

All materials which are not satisfactory for use for the purposes intended shall be rejected at the pit and disposed of in a manner satisfactory to the Engineer.

If the Contractor excavates more material than is required, the excess will not be measured for payment.

All work and materials required to build and maintain borrow haul roads and obliteration of haul roads in accordance with subsection 104.06, "Final Clean Up," shall be considered subsidiary to the "borrow" item and no further compensation will be allowed therefor.

203.03.14 Foundation. When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is to be built one-half (1/2) width at a time, the slopes that are steeper than four to one (4:1) when measured at right angles to the roadway shall be continuously benched as the work is brought up in layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment material at the Contractor's expense, unless the width of excavation required by the Engineer exceeds six (6) feet, in which case the excavated material in excess of six (6) feet will be measured and paid for as roadway excavation.

All foundations for embankment shall be cleared and grubbed in accordance with Section 201, "Clearing and Grubbing."

In designated areas, unsuitable material shall be removed and disposed of as prescribed in subsection 203.03.02, "Unsuitable Material."

Where twelve (12) inches or less of embankment is placed over existing bituminous surface, such surface shall be removed and incorporated in the embankment or otherwise disposed of as approved by the Engineer. Where more than twelve (12) inches of embankment is placed over existing bituminous surface, such surface shall be left undisturbed. Measurement for removal of existing bituminous material will be as prescribed in subsection

203.04.01, "Measurement," and paid for as roadway excavation unless the contract documents specifically call for payment under Section 202, "Removal of Structures and Obstructions."

203.03.15 Embankment Material. Embankments shall be constructed with suitable materials, excavated as prescribed and with any excess materials from other operations which are acceptable and suitable for use.

All materials used in embankments shall be free from objectionable material such as leaves, grass, roots, logs, stumps, brush, or other perishable material.

When there is a choice of material and when practicable, the excavation shall be made so the best material will be placed on top of the embankment for at least one (1) foot in depth. This paragraph shall not be interpreted as to require the Contractor to stockpile and subsequently rehandle embankment materials except as provided in subsection 203.03.09, "Selected Material."

Material shall not be placed in the embankment when either the material, foundation, or the embankment on which it would be placed is frozen.

Where embankments are to be made of material from rock cuts or other material which is unsuitable for finishing the roadbed, the upper six (6) inches of the roadbed shall be formed of approved material.

203.03.16 Placing Embankment. For embankment or backfill deposited against structures, attention is directed to subsection 207.03.02, "Placing and Compacting at Abutments, Piers, Wingwalls, and Retaining Walls."

Where structure abutments are placed on embankment, the embankment shall be constructed to subgrade elevation prior to excavating for the construction of the abutment. Structure excavation shall be measured for payment as set forth in subsection 206.04.01, "Measurement." Where the abutment is supported on piles, the embankment shall be constructed to the elevation of the bottom of the footing.

Where structures are located under a rock embankment, they shall be covered with not less than two (2) feet of satisfactory soil or granular materials before the embankment is placed over the structure.

Embankments shall, except as hereinafter specified, be constructed in layers. The construction of an embankment shall begin at the lowest point of the fill below the grade and the bottom of ravines. Individual layers shall be spread evenly to uniform thickness throughout and parallel with the finished grade for the full width of the embankment, unless otherwise permitted. The thickness of the layer shall be as necessary to secure the required compaction with an eight (8) inch maximum thickness before compaction. Excepted provisions are hereinafter outlined for placing in marsh and placement of rocks.

When embankments are constructed across wet or swampy ground which will not support the weight of heavy hauling and spreading equipment, the Contractor will be expected to choose such methods of embankment construction and to use such hauling and spreading equipment as will least disturb the soft foundation. When soft foundations are encountered, and when approved by the Engineer, the lower part of the fill may be constructed by dumping and

spreading successive vehicle loads in a uniformly distributed layer of a thickness not greater than that necessary to support the vehicle while placing subsequent layers, after which the remainder of the embankment shall be constructed in layers and compacted as specified.

It is not the policy of the Department to allow an increase in the planned depth of embankment material over soft, wet, or swampy ground for the sole purpose of providing support for heavy hauling and spreading equipment, unless the Contractor proves to the satisfaction of the Engineer that the planned depth is inadequate to support light hauling vehicles. If it proves necessary for the Contractor to use smaller hauling vehicles or different methods of embankment construction than he had originally contemplated in order to comply with the foregoing, such shall not be the basis for a claim for extra compensation against the Department; the unit contract price for the various pay items involved shall be full compensation for all labor, materials, and equipment necessary to perform the work as outlined herein.

Embankment which, in the opinion of the Engineer, contains a sufficient quantity of rock larger than four (4) inches in size shall be considered as "Rock Embankment." The materials shall be spread in a uniform horizontal layer over the full width of the embankment. The layer thickness shall not exceed one and one-third ($1\frac{1}{3}$) times the vertical dimension of maximum size material larger than eight (8) inches. The largest size rock allowed in the embankment will be three (3) feet measured in vertical direction and rocks larger than this shall be broken up before being placed in the embankment. Rock to be wasted may exceed three (3) feet and be disposed of in an inconspicuous manner approved by the Engineer.

In rock fills where end dumping is employed, direct end dumping upon the previously constructed layer of embankment will not be permitted. Rock shall be dumped on the layer of embankment being constructed and dozed ahead into place. Care shall be exercised as much as practicable to work the fines and smaller rock into the spaces between the larger rock. Compaction will be required as provided in subsection 203.03.18, "Compaction, Rock Embankment."

To the extent of project requirements for embankment, all rock from excavation shall be used for embankment. The Contractor shall plan his grading operation to use rock which may be encountered in excavation in accordance with the following provisions:

Rock, in general, shall be placed so as to form the base of embankment for the full width of the cross section; on the side slopes or slopes of a new embankment being placed; on the side slopes or slopes of an embankment already in place requiring widening or where excess rock may be wasted; or on the side slopes and top of rolled embankment made of embankment materials other than rock.

The Contractor shall not place large rock in embankments where piles will be driven. The Contractor shall be responsible for penetrating the embankment with specified piles.

When rock and other embankment materials are excavated at approximately the same time, the rock shall be distributed throughout the fill and not nested in one (1) location.

When there is insufficient material other than rock in the excavation to permit properly compacted layers, the rock shall be placed for the full cross section width with the larger rocks well distributed and the void spaces filled with the smaller rocks and fragments.

When shown on the plans or considered necessary by the Engineer, embankments shall be built to such elevation above required grade to allow for settlement, or sufficient surcharge shall be placed above the required elevation of earth grade over deposits of unstable material to secure displacement or settlement. Surcharge shall be removed only after the fill has reached stability or the required settlement.

At locations that are inaccessible to the roller, the embankment shall be brought up in layers of the thickness specified and each layer shall be compacted thoroughly with mechanical tampers or by hand tamping.

203.03.17 Compaction, Dirt Embankment. Optimum moisture content of the various soils will be determined by the Engineer. When necessary, each layer, before being compacted, shall be processed as required in order to bring its moisture content within the prescribed limits. The material shall be wetted by the application of water or dried as necessary and either process may be carried out either on the embankment or at the source of the material or otherwise as approved by the Engineer. Full compensation for any work involved in wetting or drying embankment material to obtain the required moisture content shall be considered as included in the contract unit price bid for excavating or furnishing the material and no additional compensation will be allowed therefor.

Hauling and leveling equipment shall be routed and distributed full width over each layer of the fill in such a manner as to uniformly distribute the compaction afforded thereby. In addition to hauling and leveling equipment, the Contractor shall provide compaction equipment that is specifically designed and manufactured for the purpose of compacting dirt embankments. Said compaction equipment shall work continuously with the grading equipment.

The base of cuts, natural ground having less than five (5) feet of embankment, measured from the subgrade, and embankment material, shall be compacted to not less than ninety (90) percent of the maximum density as determined by Test Method No. Nev. T101. Test Methods No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer. When natural ground material is encountered that cannot be compacted to the required density, compaction requirements shall be determined by the Engineer.

All selected borrow and structure backfill placed within the limits of embankments shown on the plans for approaches to bridges shall be compacted to not less than ninety-five (95) percent of the maximum density as determined by Test Method No. Nev. T101. Test Methods No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

It is to be expected that a loss of density in the upper portion of each subgrade may occur due to the elements, or for lapse of time, or for other

reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed therefor. The requirements of this paragraph shall also apply to subgrades that were constructed under previous contracts.

203.03.18 Compaction, Rock Embankment. Field density tests will not be required on rock embankment. In lieu thereof, the required compaction shall be tested by proof rolling. In this case, compaction shall be attained and tested by using construction methods and equipment as follows:

(a) Methods. The material for the embankment shall be deposited, spread, and leveled the full width of the embankment, and in layers not exceeding eight (8) inches in thickness before compaction, except large rock fills in which the layer thickness may be one and one-third (1 1/3) times the vertical dimension of maximum size material. The maximum layer thickness shall not exceed four (4) feet.

Hauling and leveling equipment shall be routed and distributed over each layer of the fill in such a manner as to make use of the compaction afforded thereby. In addition, one (1) of the rollers, vibrators, or compactors meeting the requirements set forth under paragraph (b) below, shall compact the embankment full width with a minimum of three (3) complete passes for each layer of embankment. The compacting equipment shall not exceed a speed of five (5) miles per hour and shall work continuously with the grading equipment.

Rolling shall be done in a longitudinal direction along the embankment and shall generally begin at the outer edges and progress toward the center. The travel paths of traffic and construction equipment shall be kept dispersed over the entire width of the embankment so as to aid in obtaining uniform compaction. Weights of equipment used in making embankments over soil having an excessive moisture content may be limited, if, in the judgment of the Engineer, such limitations are necessary in order to maintain the fill in a satisfactory condition.

Water shall be applied to the embankment in the amount necessary to obtain the required compaction.

(b) Equipment. Compaction equipment shall be adequately designed to obtain compaction requirements without adverse shoving, rutting, displacement, or loosening and shall meet the requirements hereinafter specified. Rollers shall have displayed thereon, in permanent legible characters, the manufacturer's guaranteed net operating weights as distributed on each axle.

Sheepsfoot or tamping rollers shall consist of metal drums or shells, not less than four (4) feet in diameter, equipped with self-cleaning tamping feet projecting at least seven (7) inches from the face of the drum or shell. The cross sectional area of the face of each tamping foot shall be not less than four (4) nor more than twelve (12) square inches. The feet shall be uniformly spaced on the roller. The weight and dimensions of the roller, the number, spacing, and dimensions of the tamping feet and the provisions for adding ballast, shall be such that the total load on a single row of the tamping feet in contact with a level surface can be made as great as two hundred (200) pounds per inch of length of roller drum. The weight shall be adjusted to that which

will produce the specified density with the least number of passes. Tamping rollers shall make at least three (3) complete coverages of the material being compacted and rolling shall continue until the tamping feet "build up" or "walk out" of the surface.

Grid rollers shall consist of at least two (2) similar metal drums, not less than five (5) feet in diameter, whose cylindrical faces present the appearance of an open woven bar mesh. The drums shall be at least two and one-half (2½) feet long and they shall be independently mounted close together on the same axle. The complete roller, when operating without ballast, shall weigh not over six (6) tons or two hundred (200) pounds per inch of length of roller drum. Arrangements shall be provided for adding ballast, to such an extent that the total weight of the unit can be increased to at least fifteen (15) tons and four hundred fifty (450) pounds per inch of length of roller drum.

Pneumatic tired rollers shall be of an approved, self-propelled, reversible type and shall have not less than seven (7) wheels mounting pneumatic tires of equal size which may be either treaded or smooth faced, but which shall all be alike. Wheels shall be equally spaced along both axle lines so that their center to center distance is not greater than one and seven-eighths (1⅞) times the nominal tire width and they shall be arranged so that those on one (1) axle track midway between those on the other. Tires shall be capable of operating at inflation pressures up to one hundred twenty (120) pounds per square inch. They shall be kept uniformly inflated at whatever operating pressure is specified so that the difference between the pressure in any two (2) tires shall never exceed five (5) pounds per square inch. The Contractor shall provide means for checking the tire pressure on the job at any time. For each size and type of tire used, the Contractor shall furnish the Engineer a copy of the tire manufacturer's chart showing the internal volume of the tire as well as the relationship between wheel load, inflation pressure, and tire contact width and area. The roller shall be equipped with a means of adjusting its total weight by ballasting so that the load per wheel can be varied from three thousand five hundred (3,500) to eight thousand (8,000) pounds. The Contractor shall furnish the Engineer a copy of the roller manufacturer's calibration chart for the ballast box showing the empty or tare weight of the roller. In operating, the tire inflation pressure and the wheel loads shall be adjusted as required to meet the requirements of each particular application and of the material being rolled. On the axle having an even number of wheels, the wheels shall be arranged to oscillate in pairs or they may be individually sprung. The roller shall be equipped with dual operating controls, power steering and some type of fluid drive or torque converter.

Pneumatic tired rollers meeting the requirements of the proof roller may be used in lieu of those specified above.

Pneumatic tired compactors shall have not less than four (4) wheels abreast on the line of the main axle. The compactor shall be so articulated or shall have pairs of wheels mounted on oscillating axles in such a manner as to insure that a constant and uniform load is carried by each wheel. Wheels shall be uniformly spaced along axle lines so that their center to center distance is not greater than one and three-fourths (1¾) times the nominal tire width. If there is more than one (1) line of axles, then the wheels on each line shall be

spaced the same distance apart and shall be so aligned that the wheels on one (1) axle will track midway between those on the other. All tires shall be of equal size and diameter and shall be capable of operating at an air pressure of at least ninety (90) pounds per square inch. They shall be kept uniformly inflated so that the difference in the pressure in any two (2) tires shall never exceed five (5) pounds per square inch and means shall be provided for checking the tire pressure on the job at any time. For each size and type of tire used, the Contractor shall furnish the Engineer a copy of the tire manufacturer's chart showing the internal volume of the tire as well as the relationship between wheel load, tire inflation pressure, and tire contact width and area. When operating light, no wheel on any axle shall carry a load of more than five thousand (5,000) pounds. Means shall be provided for adding sufficient ballast so that each wheel may be loaded to at least twenty-five thousand (25,000) pounds. In addition, the compactor shall be capable of applying to the ground, loads as great as fifty (50) tons and twelve hundred (1,200) pounds per linear inch on nominal tire width, measured along an axle line. The weight of the compactor and the air pressure in the tire shall be adjusted to that which will produce the specified density with the least number of passes without exceeding the shear value of the soil. The Contractor shall furnish the Engineer with a copy of the roller manufacturer's calibration chart for the ballast box showing the volume of the box, in cubic feet, for at least three (3) inch increment of depth and also showing the empty or tare weight of the roller. Compactors shall make at least two (2) complete coverages of each layer of material being compacted or at least four (4) coverages in the cases of compactors having only a single line of axles. The compactor, together with its towing unit, if any, shall be capable of making a one hundred eighty (180) degree turn in a width of not over thirty (30) feet.

Vibratory compactors shall not be used until approved by the Engineer.

The proof roller shall be a pneumatic tired roller or pneumatic tired compactor weighing not less than fifty (50) tons and capable of applying to the ground loads of not less than twenty-five thousand (25,000) pounds per wheel. All tires shall be of equal size and diameter and shall be capable of operating at an air pressure of at least ninety (90) pounds per square inch. They shall be kept uniformly inflated so that the difference in the pressures in any two (2) tires shall never exceed five (5) pounds per square inch and means shall be provided by the Contractor for checking the tire pressure on the job at any time.

(c) Tests. Subsequent layers shall not be placed until the previous layer of the embankment is compacted to the degree that no further appreciable deflection is evidenced under the action of proof rolling equipment, as determined by the Engineer.

Rolling and proof rolling may be deleted on any layer or portion thereof when, in the judgment of the Engineer, accomplishment is physically impractical.

Payment for rolling and proof rolling or for the correction of any subgrade weakness or deficiencies disclosed by the proof rolling operation shall be considered subsidiary to the price bid for the "excavation" item.

203.03.19 Maintenance. Embankment material which may be lost or

displaced as a result of natural settlement of the ground or foundation upon which the embankment is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow, etc. The quantity of material required will be paid for at the regular contract price for the type of materials used, also overhaul, if applicable, and no additional compensation will be allowed therefor.

The Contractor shall, at his expense, remove and replace with acceptable material, any embankment or portion thereof which has been constructed with unapproved material as well as remove and replace portions of the embankment which may become unstable or displaced as the result of carelessness or negligence on his part.

METHOD OF MEASUREMENT

203.04.01 Measurement. Unless otherwise specified, excavation will be measured on a volume basis by cross sectioning the area to be excavated and computing neat lines for an end area. The average end area method will be used with no allowance made for curvature. If for any reason it is impossible or impractical to measure quantities by average end areas, the Engineer will compute the quantities by a method which, in his opinion, is best suited to obtain an accurate determination.

The quantity of excavation to be measured for payment will be the number of cubic yards excavated and placed as required. The estimated quantities shown on the plans, plus or minus authorized quantity changes, will be the quantity used for payment. The State or the Contractor may, however, request a final measurement, in which case the final cross sections will be taken. When final cross sections are taken, the determination of quantities derived therefrom will be the quantities used for payment. Furthermore, when the Contractor requests final measurement, and quantities thus determined are less than the planned quantities plus authorized changes, the Contractor shall reimburse the State for the State's expenses incurred by such final measurement.

When changes are made during construction such as widening cuts, changing grades, disposing of unsuitable material, stockpiling selected material, and other changes resulting in increases or decreases in quantities, then additional measurements for payment will be made by the Engineer as hereinafter outlined:

(a) Unsuitable Material. When the removal and disposal of unsuitable material is shown in the contract documents, such material will be measured for payment as excavation for the related item.

Removal and disposal of unsuitable material, not shown on the plans, will be measured and paid for as "roadway excavation" and "overhaul." However, if removal and disposal of unsuitable material not shown on the plans requires special equipment or unusual operations, it may be paid for as extra work according to the provisions of subsection 104.03, "Extra Work."

No measurement will be made of suitable material temporarily removed and replaced to facilitate compaction of material.

(b) Overbreak. All sideslope overbreak as defined in subsection 203.03.05, "Overbreak," shall not be paid for.

Rock removed to a maximum depth of six (6) inches below subgrade will be measured for payment provided the rock has been removed sufficiently to permit accurate cross sectioning. Replacement to this depth shall be with material designated on the plans or approved by the Engineer and will be measured and paid for at the contract unit price for the material used.

Rock loosened or removed in excess of six (6) inches below subgrade will not be measured or paid for. When ordered by the Engineer, the loosened material will be removed and the resultant space refilled with approved material at the expense of the Contractor.

(c) Widening Cuts. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section and before the excavation is substantially completed, the material shall be classified as "roadway excavation" and shall be paid for at the contract bid price. However, if widening cuts requires special equipment, or unusual and extra expense, it may be paid for as extra work according to the provisions of subsection 104.03, "Extra Work."

(d) Selected Material. Selected material stockpiled as provided in subsection 203.03.09, "Selected Material," will be measured for payment as roadway excavation both in its original position and also from the stockpile. Measurement of the material taken from stockpile will be made of the volume actually removed.

(e) Surplus Material. Surplus excavated material will be measured for payment as roadway excavation and no further compensation will be allowed by virtue of the method of disposing, placing, or widening embankments caused from such surplus material. Any additional "overhaul" resulting from the disposal of surplus material beyond the designated balance will be measured for payment.

(f) Slides and Slipouts. In the event of slides and slipouts, the Engineer and Contractor shall negotiate in each case and decide the relative difficulty of performing the work, and payment will be made either as "roadway excavation" or as "extra work" as provided in subsection 104.03, "Extra Work."

Where slopes have been previously completed by the Contractor, the cost of resloping required in areas where unstable material is removed will be paid for as extra work as provided in subsection 104.03, "Extra Work."

The cost of pioneering work necessary to make slide or slipout areas accessible to normal excavation equipment and the cost of necessary clearing and grubbing will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Only those quantities of slide or slipout material which are authorized and actually removed will be measured for payment.

(g) Overhaul. Attention is directed to Section 205, "Overhaul."

Excavation in excess of the staked or authorized cross section will not be measured for payment, except as outlined above.

Material used for surcharge, whether shown on the plans or called for by the Engineer, will be measured for payment as roadway excavation. If the surcharge is to be placed and removed under the terms of the same contract, the material will be measured for payment both in its original position and also from the surcharge position.

Earthwork quantities within the limits of "slope rounding" will not be measured for payment.

V-type ditches will be measured parallel to the ground and each one hundred (100) linear feet shall constitute a unit of measure. The volume of excavation for such ditches will not be measured for payment.

All excavation items shall be measured for payment in their original position.

The quantity of borrow embankment or selected borrow embankment to be measured for payment shall be the required number of cubic yards of embankment complete and in place in the accepted work. The estimated quantities shown on the plans, plus or minus authorized quantity changes, will be the quantity used for payment. Borrow embankment or selected borrow embankment material placed outside of the staked or authorized cross section will not be measured for payment. The State or the Contractor may, however, request a final measurement in which case final cross sections will be taken. When final cross sections are taken the determination of quantities derived therefrom will be the quantities used for payment. Furthermore, when the Contractor requests final measurement and the quantities thus determined are less than the planned quantities plus authorized changes, the Contractor shall reimburse the State for the State's expenses incurred by such final measurement.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

203.05.01 Payment. The accepted quantities of excavation measured as specified in subsection 203.04.01, "Measurement," will be paid for at the contract unit price bid for each of the pay items listed in the bid schedule. Such price shall include excavating, loading, hauling (except as provided in Section 205, "Overhaul"), depositing, spreading, watering, compacting, and maintaining the material complete and in place.

The accepted quantities of material for borrow embankment or selected borrow embankment will be paid for at the contract unit price bid per cubic yard for "borrow embankment" or "selected borrow embankment," which price shall be full compensation for furnishing all materials, loading, hauling, depositing, spreading, watering, compacting, and maintaining the material complete and in place.

Removal of overburden from material sources (if required) will not be measured or paid for directly but the cost thereof shall be considered included in the contract unit price bid for other items of work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Roadway Excavation	Cubic Yard
Drainage Excavation	Cubic Yard
Channel Excavation	Cubic Yard
Borrow Embankment	Cubic Yard
Borrow Excavation	Cubic Yard
V-type Ditches	Stations
Selected Borrow Embankment	Cubic Yard
Selected Borrow Excavation	Cubic Yard

6

SECTION 204

ROUNDED AND TRANSITION SLOPES

DESCRIPTION

204.01.01 General. This work shall consist of rounding and shaping slopes in accordance with the plans and where designated by the Engineer.

CONSTRUCTION

204.03.01 General. The top of cut slopes shall be rounded by excavating to blend the cut slopes with the adjacent natural terrain. At the intersection of cuts and fills, slopes shall be adjusted and warped to blend into each other or into the natural ground surface without noticeable break.

Slopes will be staked for flattening and rounding in places where the material is other than solid rock. Rock formations such as shales, decomposed sandstone, and granite that can be readily excavated by means of hand tools, shall have the slopes flattened and rounded the same as earth slopes. A layer of earth overlying a rock cut shall be rounded above the rock the same as earth slopes. Where the depth of cut is insufficient to provide the full rounding required, the distance for rounding shall be proportionately adjusted.

Slope rounding and warping shall also apply to all drainage ditches when such rounding will improve the appearance of the roadside.

Whenever the treatment of the slopes may destroy or injure standing timber, trees, or other vegetation which should be preserved, adjustments in slope grading will be made. These adjustments shall be effected by a gradual transition from the theoretical grading section required.

The degree of smoothness required in rounding and warping slopes shall be as specified in subsection 203.03.06, "Slopes."

METHOD OF MEASUREMENT

204.04.01 Measurement. The quantity of rounded cut slopes or roadway ditch slopes to be paid for shall be measured in linear feet of slopes, treated as specified, measured along the roadway ditch each side of the roadway centerline. The quantity of rounded embankment slopes to be paid for shall be measured in linear feet, treated as specified, measured along the centerline of the embankment to be rounded, and each side shall be considered separately. In all cases, each one hundred (100) feet shall constitute the unit of one (1) station. Earthwork quantities within the limits of "slope rounding" will not be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

204.05.01 Payment. The accepted quantity of slope rounding measured as specified in subsection 204.04.01, "Measurement," will be paid for at the contract unit price bid per station of the completed work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Slope Rounding	Stations

SECTION 205

OVERHAUL

DESCRIPTION

205.01.01 General. This work shall consist of authorized hauling of roadway excavation in excess of the free-haul distance.

Free-haul distance is the specified distance that excavated material shall be hauled without additional compensation. Unless otherwise provided in the contract documents, the free-haul distance shall be two thousand (2,000) feet.

METHOD OF MEASUREMENT

205.04.01 Measurement. The item of "overhaul" applies to roadway excavation only. Overhaul involving any other material will not be measured or paid for directly but the cost thereof shall be considered included in the contract unit price bid for the particular item involved and no further compensation will be allowed therefor.

The quantity of overhaul measured for payment will be the number of yard miles calculated and shown on the plans, plus or minus quantities covered by approved changes. The Engineer or the Contractor may request recalculation of quantities and such request shall be in writing. When quantities are recalculated, the quantities derived therefrom will be the quantities used for payment. All calculations will be made according to the requirements of this subsection.

The limit of free-haul shall be determined from a mass diagram by fixing on the volume curve, two (2) points, one (1) on each side of the neutral grade point, one (1) in excavation and the other in embankment, such that the distance between them equals the free-haul distance, and the included quantity of excavation and embankment are in balance. All materials within the free-haul limit shall be eliminated from further consideration. The distance between the center of gravity of the remaining mass of excavation and the remaining mass of embankment minus the free-haul distance shall be the overhaul distance. The quantity of overhaul shall be the product of the overhaul distance measured in miles multiplied by the number of cubic yards of material hauled in excess of the free-haul distance. Analytical methods may be used for computing overhaul in lieu of the mass diagram method described herein.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

205.05.01 Payment. The accepted quantities of overhaul measured as specified in subsection 205.04.01, "Measurement," will be paid for at the contract unit price bid per yard mile of the completed work.

When overhaul does not appear as an item in the proposal, the contract unit

price bid per cubic yard for roadway excavation shall be considered as including payment for overhaul.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Overhaul	Yard Mile

SECTION 206

STRUCTURE EXCAVATION

DESCRIPTION

206.01.01 General. This work shall consist of the removal of all material of whatever nature encountered for the construction of foundations for bridges, retaining walls, headwalls for culverts, and other structures; the excavation of trenches for pipe and box culverts, cut-off walls for slope paving and concrete aprons, footings for riprap, and other excavation specifically designated on the plans, in these specifications, or in the special provisions as structure excavation, including the work of disposing of surplus material and cleaning up the sites. Structure excavation shall include dewatering and the furnishing of all equipment and the construction or installation of all cofferdams, cribs, and other facilities which may be necessary to perform the excavations and the subsequent removal of such facilities except where they are required or permitted by the plans or specifications to remain in place. it shall also include all the necessary clearing and grubbing within the proposed structure area and removing old structures or parts thereof as required if the proposal does not include separate bid items for such work.

For specific requirements pertaining to the excavation involved in the installation of pipe culverts and underground piping, attention is directed to those sections of these specifications governing such work.

When shoring, cribbing, or cofferdams are to be used, the Contractor shall be responsible for designing and constructing such shoring, cribbing, or cofferdams. The shoring, cribbing, or cofferdam shall be safe and adequate to provide the necessary rigidity and support the loads imposed.

Design calculations along with detailed drawings of the shoring, cribbing, or cofferdam shall be furnished by the Contractor to the Engineer for approval in accordance with subsection 105.02, "Plans and Working Drawings," of these specifications. If such plans are not satisfactory to the Engineer, the Contractor shall make such changes in them as may be required. Construction of such shoring, cribbing, or cofferdam shall not begin until the Engineer has reviewed and approved the drawings.

206.01.02 Classification. Classification of structure excavation will not be made on the basis of materials or conditions encountered. Classification of excavation, if made, will be on the basis of the material removed between certain elevations, and such classification as shown on the plans or set forth in the special provisions shall not be changed regardless of the material encountered.

CONSTRUCTION

206.03.01 General. The Contractor shall notify the Engineer a sufficient time in advance of the beginning of excavation for structures so that elevations and measurements may be taken of the existing ground before it is disturbed

and of existing substructure units within the limits of excavation for structures before they are removed. Any material excavated or removed before these measurements have been taken will not be paid for.

The excavated area shall conform to the outlines of the footings, as shown on the plans, and shall be of sufficient size to permit placing of the full width and length of the footings shown. The elevation of the bottoms of footings as shown on the plans shall be considered as approximate only, and the Engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

Unless otherwise permitted by the Engineer, foundations for culvert pipe and structures shall be compacted to not less than ninety (90) percent of the maximum density as determined by Test Method No. Nev. T101. Test Methods No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

All rock or other hard foundation material shall be freed from all loose material, cleaned and cut to a firm surface, either level, stepped, or serrated, as may be permitted by the Engineer. All seams and crevices shall be cleaned out and filled with concrete mortar or grout.

Where masonry is to rest on material other than rock or boulders, special care must be given not to destroy its bearing value.

Should the Contractor remove foundation excavation below grade, he shall backfill to the required elevation at his own expense with backfill or with foundation fill in a manner satisfactory to the Engineer.

Wet pits shall be unwatered for inspection and for construction of foundations unless otherwise provided.

Excavated material which is suitable for backfilling shall be so utilized or used in embankments, in a manner satisfactory to the Engineer. Surplus or unsuitable material shall be disposed of so as to cause no obstruction to flow of streams; or otherwise impair the efficiency or appearance of the structure. It shall be disposed of in such manner as to prevent damage to property or the creation of unsightly conditions, and shall not be placed where it will interfere with the operation of drains or impair the roadway ditches, etc.

206.03.02 Inspection. After each excavation is completed, the Contractor shall notify the Engineer, and no masonry shall be placed until the Engineer has approved the depth of excavation and the character of the foundation material.

METHOD OF MEASUREMENT

206.04.01 Measurement. The quantity of structure excavation measured for payment will be the number of cubic yards calculated and shown on the plans, plus or minus quantities covered by approved changes. The Engineer or the Contractor may request recalculation if a possible error is suspected in the quantities shown on the plans. If the Contractor requests recalculation of quantities, such request shall be in writing. When quantities are recalculated, the quantities derived therefrom will be the quantities used for payment. All calculations will be made according to the dimensions shown

on the plans. Only those quantities complete and in place will be measured for payment.

The yardage of water or any other liquid will not be included in the measurement for payment, except that the yardage of mud, muck, or similar semi-solid matter not resulting from construction operations and which cannot be pumped or drained away shall be included.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

206.05.01 Payment. The accepted quantity of structure excavation measured as provided in subsection 206.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard, which payment will be full compensation for clearing, grubbing, cofferdams, cribs, sheeting, shoring, bracing, pumping, unwatering, and disposing of all materials, as well as any other additional work which may be required to comply with safety regulations, including, but not limited to, additional sloping outside the designated pay limits.

No compensation will be made for the removal and disposal of material which may come into an excavation from outside the designated limits or for the removal and disposal of swell material resulting from the driving of piles in an excavation.

When an item for structure excavation does not appear in the proposal, structure excavation will be considered as incidental to the installation of the structure and compensation shall be considered as being included in the contract prices for other items of work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Structure Excavation	Cubic Yard

SECTION 207

BACKFILL

DESCRIPTION

207.01.01 General. This work shall consist of placing and compacting, to the lines designated on the plans or as established by the Engineer, backfill or granular backfill material in excavations for bridges, retaining walls, headwalls or culverts, and other structures; placing and compacting backfill or granular backfill material in trenches for culverts and pipes; and other backfill specifically designated in the contract documents as structure backfill. This item does not include backfilling minor miscellaneous structure excavations outside the limits of the roadway.

When the terms "backfill" or "structure backfill" are used herein, they shall be construed to mean backfill or granular backfill, or both.

MATERIALS

207.02.01 Backfill. Material used for backfill shall be of a quality acceptable to the Engineer. The backfill material shall be free from stones or lumps of material exceeding three (3) inches in greatest dimension and shall be free from sod, frozen earth, and organic materials. Acceptable material from excavation may be used for backfilling unless granular backfill is specified and the material from excavation does not conform to the requirements therefor.

Material used for backfill shall conform to the Materials and Testing Laboratory's current requirements for pH, resistivity, and sodium sulphate for the type of structure or pipe to be backfilled. The material shall be tested and approved prior to use.

207.02.02 Granular Backfill. Material used for granular backfill shall consist of natural sand or a mixture of sand with gravel, crushed gravel, crushed stone, or other broken or fragmented material to fill the voids in the coarser material. In addition thereto, the material shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
3″	100
No. 4	35–100
No. 200	0–15

The liquid limit of the material shall not be greater than thirty-five (35) and the plasticity index shall not be more than ten (10).

Material used for granular backfill shall conform to the Materials and Testing Laboratory's current requirements for pH, resistivity, and sodium sulphate for the type of structure or pipe to be backfilled. The material shall be tested and approved prior to use.

CONSTRUCTION

207.03.01 General. Compaction of backfill or embankment around all structures shall be secured with mechanical tamping units and the material shall be placed at a rate which will permit efficient use of mechanical tampers in securing the required compaction.

Unless otherwise permitted by the Engineer, foundations for culvert pipe and reinforced concrete boxes shall be compacted to not less than ninety (90) percent of the maximum density as determined by Test Method No. Nev. T101. Test Methods No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

Backfill material shall be placed in uniform horizontal layers not exceeding eight (8) inches in loose thickness before compaction and shall be brought up uniformly on all sides of the structure or improvement. Each layer of backfill shall be moistened as necessary and thoroughly compacted until ninety (90) percent of the maximum density is achieved, except that each layer of backfill so placed within the limits shown on the plans for selected borrow embankments for approaches to bridges shall be thoroughly compacted until ninety-five (95) percent of the maximum density is achieved. In all instances, Test Methods No. Nev. T101, T102, or T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

Compaction of backfill material by ponding or jetting will not be permitted.

Material resulting from structure excavation and not used as structure backfill shall be deposited in roadway embankments in accordance with the requirements specified elsewhere or otherwise disposed of along the roadway in a manner approved by the Engineer and no additional compensation will be allowed for such work.

Structure backfill shall not be placed until the structure or facilities have been inspected by the Engineer and approved for backfilling. Backfill material shall not be deposited against the back of concrete abutments, concrete retaining walls, or the outside walls of concrete box culverts until the concrete has reached an age of fourteen (14) days or the concrete has developed a strength of two thousand five hundred (2,500) pounds per square inch in compression as determined by Test Method No. Nev. T475.

Where backfill is placed against waterproofed surfaces, care shall be taken that no damage is done to the waterproofing material.

207.03.02 Placing and Compacting at Abutments, Piers, Wingwalls, and Retaining Walls. With the approval of the Engineer, all spaces excavated and not occupied by abutments, piers, or other permanent work shall be refilled with earth up to the surface of the surrounding ground or to the limits designated on the plans or as described herein. All backfill shall be thoroughly compacted in accordance with the provisions set forth in subsection 207.03.01, "General."

Where backfill is to be placed on one (1) side of an abutment, wingwall, pier, or headwall, care shall be exercised to prevent over compacting to the point of displacing line or batter or both.

Existing slopes which are shaped so as to cause a wedge action in the backfill, shall be step-cut or benched before backfilling.

207.03.03 Placing and Compacting at Culverts. After the bedding has been prepared and the culverts installed or constructed as required by the pertinent specifications, acceptable material from excavation or from other sources shall be placed along both sides of the culvert equally in uniform layers not exceeding eight (8) inches in depth (loose measurements), wetted as required and thoroughly compacted to the density requirements as set forth in subsection 207.03.01, "General."

Special care shall be taken in placing and thoroughly compacting the material under the haunches of all pipe.

Unless otherwise directed, the backfilling shall continue as described to the level of the ground or to an elevation six (6) inches above the structure in the case of a pipe culvert in projection, or even with the top of the structure in the case of an RCB culvert in projection.

No construction or other traffic shall be permitted to cross any culvert until a safe minimum depth of fill above the culvert has been placed and consolidated in accordance with these specifications. The contractor shall be solely responsible for protecting the structure from superimposed loading created by construction equipment or otherwise and shall repair any damage done to the structure or replace the structure as ordered without extra compensation.

Special care shall be taken in backfilling arches, particularly half-circle arches. The arch shall be covered in layers, each layer conforming to the shape of the arch and tamped thoroughly.

207.03.04 Placing and Compacting of Bin-Type Retaining Walls. Placing and compacting backfill material for bin-type retaining walls shall progress concurrently with the assembly of the bins, and backfilling around the outer sides thereof shall be kept approximately level with the inside fills. The materials shall be thoroughly tamped and meet the density requirements as set forth in subsection 207.03.01, "General." Care shall be exercised to completely fill the depressions of stringers and spacers without over compacting to the point of displacing them for established line and batter.

METHOD OF MEASUREMENT

207.04.01 Measurement. The quantity of backfill or granular backfill measured for payment will be the number of cubic yards calculated and shown on the plans, plus or minus quantities covered by approved changes. The Engineer or the Contractor may request recalculation if a possible error is suspected in the quantities shown on the plans. If the Contractor requests recalculation of quantities, such request shall be in writing. when quantities are recalculated, the quantities derived therefrom will be the quantities used for payment. All calculations will be made according to the dimensions shown on the plans. Only those quantities complete and in place will be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

207.05.01 Payment. The accepted quantities of backfill or granular

backfill measured as provided in subsection 207.04.01, "Measurement," will be paid at the contract unit price bid per cubic yard for backfill or granular backfill.

When structure excavation is unacceptable as backfill and backfill material is obtained from the roadway prism or from borrow or from base materials, it will be paid for both as backfill and the respective bid item from which it is obtained. When granular backfill is called for it will be paid as granular backfill only and no further compensation will be paid for borrow or base items.

Payment for backfill or granular backfill shall be full compensation for furnishing, hauling, watering, and compacting all material.

When an item for backfill does not appear in the proposal, backfill will be considered as incidental to the installation of the structure and compensation shall be considered as being included in the contract prices for other items of the work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Backfill	Cubic Yard
Granular Backfill	Cubic Yard

SECTION 208

FOUNDATION FILL

DESCRIPTION

208.01.01 General. This work shall consist of furnishing and placing sand, gravel rock, or any suitable combination of these materials in areas where unstable foundation materials have been excavated below the foundation elevation for culverts, bridges, and all other structures in accordance with these specifications and in conformity with the grades and elevations shown on the plans or established by the Engineer.

MATERIALS

208.02.01 General. Material shall be as set forth in the special provisions.

CONSTRUCTION

208.03.01 General. Unsatisfactory material shall be removed to the depth required and piles driven if designated. Foundation fill shall be placed to bring the subfoundations to the required elevation.

Compaction of foundation fill shall be secured with mechanical tamping units or other compaction methods approved by the Engineer. Material shall be placed at a rate which will permit efficient use of compaction methods.

Unless otherwise permitted by the Engineer, foundation fill shall be compacted to not less than ninety (90) percent of the maximum density as determined by Test Method No. Nev. T101. Test Methods No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

Compaction by ponding or jetting will not be permitted.

METHOD OF MEASUREMENT

208.04.01 Measurement. The quantity of foundation fill to be measured for payment will be the number of cubic yards measured in accordance with the dimensions shown on the plans or established by the Engineer.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

208.05.01 Payment. The accepted quantities of foundation fill measured as provided in subsection 208.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard of foundation fill complete and in place.

Full compensation for furnishing, hauling, placing, watering, and compacting foundation fill shall be considered as included in the contract price paid for foundation fill.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Foundation Fill	Cubic Yard

SECTION 209

DRAIN BACKFILL

DESCRIPTION

209.01.01 General. This work shall consist of furnishing, hauling, placing, and compacting drain backfill material around structures or perforated underdrains to the lines designated on the plans or established by the Engineer.

MATERIALS

209.02.01 General. Material shall conform to the requirements as set forth in subsection 704.03.01, "Drain Backfill."

CONSTRUCTION

209.03.01 Underdrains. The trench shall be excavated and drain backfill placed in accordance with the provisions of Section 607, "Underdrains."

Trenches for blind drains shall be excavated to the width and depth shown on the plans, or established by the Engineer. The trench shall be filled with drain backfill material to the depth required by the plans. Any remaining upper portion of trench shall be filled with either granular or impervious material as may be specified.

Where drain backfill is part of the structural section, it shall be compacted to not less than ninety (90) percent of the maximum density as determined by Test Method No. Nev. T101. Test Methods No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

Compacting by ponding or jetting will not be permitted.

METHOD OF MEASUREMENT

209.04.01 Measurement. The quantity of drain backfill to be measured for payment will be the number of cubic yards measured in accordance with the dimensions shown on the plans or established by the Engineer.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

209.05.01 Payment. The accepted quantities of drain backfill measured as provided in subsection 209.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard of drain backfill.

Full compensation for furnishing, hauling, placing, watering, and compacting drain backfill shall be considered as included in the contract price paid for drain backfill.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Drain Backfill	Cubic Yard

SECTION 210

WATERING

DESCRIPTION

210.01.01 General. This work shall consist of but is not limited to furnishing hauling and applying all water required for compaction of embankment foundation areas, embankments, subgrade, mineral aggregate base and surfacing materials, structure backfill, processing cement treated base or subgrade material, and for laying dust caused by grading operations and traffic.

MATERIALS

210.02.01 General. All materials shall conform to the requirements set forth in Section 722, "Water."

CONSTRUCTION

210.03.01 Equipment. Equipment used for applying water required for compacting embankment materials, subgrade, base and surfacing materials, and for laying dust shall be pressure type distributors equipped with a spray system that will ensure uniform application of water. All the watering equipment used for the application of water shall be equipped with a positive means of shutoff and the use of equipment not so equipped will not be permitted. An approved pump, pipe, hose, and nozzle equipment may be used in embankment construction. Where the head is sufficient to provide equal pressure, the pump requirement may be eliminated.

The Department does not require that watering equipment be provided with measuring or metering devices.

210.03.02 General. Water for dust control shall be applied in the amounts and on the areas designated by the Engineer.

The Contractor shall apply water in the amount necessary to attain the compaction in those materials requiring a specified density. In certain of the base courses, water shall be introduced into the aggregate at the plant and when necessary to attain the specified compaction, shall be supplemented by additional wetting as specified above.

Excavation areas and borrow pits may be watered prior to excavating material.

When water is applied directly to the roadbed, the material shall be processed by suitable equipment until the layer is uniformly wet. Care shall be taken to avoid disturbing layers which have been previously placed and compacted.

The Contractor shall make all arrangements for providing an adequate water supply. He shall negotiate with owners of supply and sign an agreement with each owner prior to removing the water. A copy of said agreement shall be

furnished the Engineer. He shall pay all royalties occurring under such agreements and shall also obtain any necessary right of way.

METHOD OF MEASUREMENT

210.04.01 Measurement. The developing of an adequate water supply, the furnishing of all necessary equipment for obtaining water from the source or sources, water, and the furnishing of equipment necessary to apply the water, will not be measured for payment.

BASIS OF PAYMENT

210.05.01 Payment. Full compensation for developing an adequate water supply, for furnishing all necessary equipment, for obtaining water from the source or sources, for water, and for furnishing of equipment necessary to apply the water, shall be considered as included in the contract unit price paid for other appropriate items and no separate payment will be made therefor.

SECTION 211

EROSION CONTROL

DESCRIPTION

211.01.01 General. This work shall consist of preparing slopes, placing and compacting topsoil, seeding, fertilizing, mulching, and placing erosion control fabric on all graded and disturbed areas in accordance with these specifications and the details shown in the contract documents.

MATERIALS

211.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the applicable requirements of this section of these specifications and Section 726, "Roadside Materials."

211.02.02 Topsoil. Unless designated in the contract documents, the Contractor shall make his own arrangements for obtaining topsoil and he shall pay all costs involved. Topsoil shall be transported directly from the source to final position unless otherwise permitted. Topsoil shall not be obtained from an area known to have noxious weeds growing in it.

Prior to removal of topsoil from the source, the Contractor shall contact the County Weed Control Agency or the State Quarantine Officer for the inspection and destruction of injurious and noxious weeds. Topsoil that has been treated with herbicides or sterilants shall be reported to the Nevada State Department of Agriculture, and an inspection certificate from that agency approving the material must be furnished to the Department prior to use of the material.

211.02.03 Seed. All seeds shall conform with all laws and regulations pertaining to the sale and shipment of seed required by the Nevada State Department of Agriculture and the Federal Seed Act. All shipments of seed shall be reported to the Nevada State Department of Agriculture for inspection. Seed shall be of the varieties and proportions specified in the contract documents.

211.02.04 Fertilizer. All fertilizer shall conform with all rules and regulations governing the registration, licensing, and collection of license fees for commercial fertilizer in the State of Nevada as required by the Nevada State Department of Agriculture. Commercial fertilizer formulation and rate of application shall be as specified in the contract documents.

211.02.05 Mulch. (a) Hay or Straw. Hay or straw shall be acceptable to the Engineer. All shipments of hay or straw shall be reported to the Nevada State Department of Agriculture for inspection. Hay or straw delivered to the project shall meet the requirements of the Nevada State Department of

Agriculture. Rate of application shall be as specified in the contract documents.

(b) Wood Cellulose Fiber. Wood cellulose fiber shall be manufactured in such a manner that after addition and agitation in slurry tanks with fertilizers, grass seeds, water, and other improved additives, the fibers in the material will become uniformly suspended to form a homogeneous slurry. When hydraulically sprayed on the ground, the material shall be uniformly impregnated with grass seed. Rate of application shall be as specified in the contract documents.

211.02.06 Tackifier. Tackifier used as a tie-down for mulch shall be as described in the contract documents.

CONSTRUCTION

211.03.01 Preparation. Excavation slopes shall be thoroughly cultivated to the depth shown in the contract documents, after which topsoil, if required by the contract, shall be uniformly spread to an approximate thickness of two (2) inches, the exact thickness will be determined by the Engineer.

Cultivation of embankment slopes and covering with topsoil will not be required unless specified in the contract documents or ordered by the Engineer. If cultivation of embankment slopes and covering with topsoil is ordered by the Engineer, the cost of such work will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Cultivation shall not be performed until all equipment is through working in the area, except equipment required to cultivate the area and spread topsoil.

After cultivation and prior to seeding, all rocks six (6) inches in smallest dimension and larger shall be removed from all slopes to be seeded and disposed of as approved by the Engineer.

211.03.02 Placement of Topsoil. Topsoil shall be evenly spread over the specified areas to the depth shown on the plans unless otherwise approved by the Engineer. After the topsoil has been spread, all large clods, hard lumps, rocks, and litter shall be raked up, removed, and disposed of by the Contractor.

Topsoil shall not be placed when the ground or topsoil is frozen, excessively wet, or in the opinion of the Engineer, in a condition detrimental to the work.

All damage occurring to existing roadbeds, shoulders, walks, curbs, or other existing adjacent structures or areas due to the Contractor's operation in hauling and placing the topsoil shall be repaired by the Contractor at his own cost and expense.

211.03.03 Compaction. All topsoil shall be compacted unless otherwise specified or approved by the Engineer. Compaction shall be by sheepsfoot roller, cleated crawler tractor, or similar equipment approved by the Engineer, which will produce a minimum of one hundred fifty (150) pounds per square inch ground pressure to a maximum of three hundred (300) pounds per square inch ground pressure. Equipment shall be so designed and constructed to produce a uniform rough textured surface ready for seeding and mulching,

and which will bond the topsoil to the underlying material. The entire area shall be covered by a minimum of four (4) passes or two (2) round trips of the roller or approved equipment. Compaction equipment shall be operated parallel to the natural flow of water on the slopes unless otherwise approved by the Engineer. Conveying the roller or approved equipment up and down the slopes shall be by means devised by the Contractor, providing that the required results are obtained to the satisfaction of the Engineer. After compaction, the finished grade of the topsoil shall be one (1) inch below the top of all curbs, catch basins, and other structures.

If, in the opinion of the Engineer, water is required to condition the topsoil for compaction, it shall be immediately furnished and applied by the method and in the amount designated by the Engineer.

211.03.04 Seeding and Fertilizing. The Contractor shall notify the Engineer not less than twenty-four (24) hours in advance of any seeding operation and he shall not begin the work until areas prepared or designated for seeding have been approved. Following the Engineer's approval, seeding and fertilizing of the approved slopes shall begin immediately.

Seeding shall not be done during windy weather or when the ground is frozen. Seed and fertilizer shall be uniformly spread over the area at the rate and mix specified in the contract documents. Seed and fertilizer may be sown by one (1) of the following methods:

(a) An approved type hydro-seeder which utilizes water as the carrying agent and maintains a continuous agitator action that will keep seed and fertilizer mixed in uniform distribution until pumped from the tank. Pump pressure shall be such as to maintain a continuous, nonfluctuating stream of solution.

(b) Approved blower equipment with an adjustable disseminating device capable of maintaining a constant, measured rate of material discharge that will ensure an even distribution of seed and fertilizer at the rates herein specified.

(c) Helicopters properly equipped for aerial seeding and fertilizing. Helicopters so equipped shall have the following:

1. Two (2) hoppers or seed compartments each capable of containing a minimum of one hundred (100) pounds of grass seed or granular fertilizer.
2. Power-driven, readily adjustable disseminating mechanisms capable of maintaining a constant, measured rate of distribution of grass seed or granular fertilizer.
3. Where liquid fertilizer is furnished in lieu of dry granular fertilizer, the helicopter shall be equipped with two (2) barrels or containers capable of containing a minimum of fifteen (15) gallons each. Distribution shall be by a spray boom of sufficient size and length, fitted with proper nozzles to distribute uniformly, liquid fertilizer as herein specified.

(d) Approved power-drawn drills, with double-disc front delivery openers, and depth bands for positive depth control. Depth control shall be set at a depth of three-fourths (3/4) inch for consistent furrow bottom placement. An approved deep furrow drill may be used where it is determined the seedbed is firm and there is little danger of soil blowing. An approved spreader may be

used for fertilizer placement. Drills and spreaders shall be calibrated before use on the project.

Areas inaccessible to above methods of application shall be seeded and fertilized by approved hand methods. Distribution of the material shall be uniform and at the rates specified.

It shall be the Contractor's responsibility to provide qualified personnel experienced in all phases of the seeding and fertilizing operation, equipment, and methods as herein specified.

211.03.05 Spreading Mulch. (a) Hay or Straw. Hay or straw mulch shall be furnished, hauled, and evenly applied at the rates indicated, and shall be spread by means of an approved type mulch spreader. The spreader shall produce a uniform distribution of the hay, without cutting or breaking it into short stalks. Areas beyond the range of the mulch spreader shall be mulched by approved hand methods. Distribution of the material shall be uniform and at the rate specified in the contract documents.

Straw, grass, hay, or shredded bark, unless otherwise specified, shall be anchored into the soil by use of a disc, sheepsfoot roller, or similar equipment approved by the Engineer. Anchoring shall be to a depth of two (2) inches, across the slope, and with no more than one (1) pass of the equipment on the same surface.

(b) Wood Cellulose Fiber. Wood cellulose fiber utilized as a mulch may be applied with seed and fertilizer by approved hydraulic equipment. The equipment shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry of the specified amount of fiber, fertilizer, seed, and water. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles which will provide a uniform distribution of the slurry.

211.03.06 Applying Tackifier. When called for in the contract documents, mulch material shall be anchored in place with tackifier as herein specified. Tackifier shall be sprayed onto the mulch. The tackifier shall contain a color additive which will assist the applicator in the uniform application of the product. Any mulch disturbed or displaced following application shall be removed, reseeded, and remulched as specified.

211.03.07 Placing Erosion Control Fabric. Erosion control fabric shall be unrolled and placed parallel to the flow of water immediately following the bringing to finished grade the area specified on the plans or the placing of seed and fertilizer. Where more than one (1) strip is required to cover the given areas, they shall overlap a minimum of four (4) inches. Ends shall overlap at least six (6) inches with the up-grade section on top. The up-slope end of each strip of fabric shall be buried in six (6) inch slots with the soil firmly tamped against it. The Engineer may require that any other edge exposed to more than normal flow of water or strong prevailing winds be buried in a similar manner. Check slots shall be placed between the ends of strips by placing a tight fold of the fabric at least six (6) inches vertically into the soil. These shall be tamped and stapled the same as up-slope ends. Check slots must be

spaced so that one (1) check slot or one (1) end occurs within each fifty (50) feet of slope.

Edges of fabric shall be buried around the edges of catch basins and other structures as herein described. Fabric must be spread evenly and smoothly and in contact with the soil at all points.

Erosion control fabric shall be held in place by approved wire staples, pins, spikes, or wooden stakes driven vertically into the soil. Fabric shall be fastened at intervals not more than three (3) feet apart in three (3) rows for each strip of fabric, with one (1) row along each edge and one (1) row alternately spaced in the middle. All ends of the fabric and check slots shall be fastened at six (6) inch intervals across their width. Fastening devices shall anchor the fabric against the soil and be driven flush with the finished grade.

METHOD OF MEASUREMENT

211.04.01 Measurement. The quantity of topsoil measured for payment will be the number of cubic yards in the haul conveyance at the point of delivery and placed in the work.

The quantity of seeding, fertilizing, mulching, and erosion control fabric measured for payment will be the number of acres or square yards calculated and shown on the plans, plus or minus quantities covered by approved changes.

The Engineer or the Contractor may request recalculation if a possible error is suspected in the quantities shown on the plans. If the Contractor requests recalculation of quantities, such request shall be in writing. When quantities are recalculated, the quantities derived therefrom will be the quantities used for payment. All calculations will be made according to the dimensions shown on the plans. Only those quantities complete and in place will be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

211.05.01 Payment. The accepted quantity of topsoil measured as provided in subsection 211.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard of topsoil which price shall include hauling and placing.

The accepted quantities of seeding, fertilizing, mulching, and erosion control fabric will be paid for at the contract unit price bid per acre or square yard as set forth in the proposal.

The contract unit price bid for seeding shall also be considered full compensation for removing and disposing of rocks, six (6) inches in smallest dimension and larger, from slopes as specified in subsection 211.03.01.

Water will be considered subsidiary to the major items of work and no further compensation will be allowed therefor.

Tackifier will be considered subsidiary to the item "mulching" and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Topsoil	Cubic Yard
Seeding (type)	Acre, Square Yard
Fertilizing (type)	Acre, Square Yard
Mulching (type)	Acre, Square Yard
Erosion Control	Fabric

SECTION 212

LANDSCAPING

DESCRIPTION

212.01.01 General. This work shall consist of furnishing and planting trees, shrubs, and ground covers where shown on the plans or established by the Engineer, all in accordance with specifications and accepted horticultural practices.

MATERIALS

212.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the applicable requirements of Section 726, "Roadside Materials."

212.02.02 Nomenclature. Nomenclature for plant names and varieties shall be in accordance with the latest edition of "Standardized Plant Names" as prepared by the American Joint Committee on Horticultural Nomenclature.

All plant material will be classified by group as follows:

Plants, Group A	Denotes canned plant material*
Plants, Group B	Denotes balled and burlapped plant material
Plants, Group C	Denotes ground cover
Plants, Group D	Denotes grass (turf)
Plants, Group E	Denotes grass (meadow)

*The size of canned plant material will be indicated in the description of the particular bid item. For example, Item No. 212 0301, "Plants (Group A-1)" denotes a one (1) gallon size, Item No. 212 0302, "Plants (Group A-2)" a two (2) gallon size, and so on.

212.02.03 Quality of Plant Materials. It is the intent of these specifications that all plant material meet the standards as set forth herein, throughout the life of the contract. During inspections, as set forth hereinafter, all plant material will be judged and rejections shall be based upon these standards.

It is to be understood that when plant materials do not meet the standards and are rejected, that no consideration will be given to the possibility of survival.

All plants shall be first-class nursery grown representatives of their normal species and shall be true to type or name as shown on the plans and shall conform to the American Standard for Nursery Stock, No. 1 grade, American Association of Nurserymen, Inc., latest edition. ASA Spec. Z60.1, and shall be tagged in accordance with the most recent standard practice recommended by the American Association of Nurserymen and to the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.

All plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations. Inspection certificates required by law shall accompany each shipment of plants, and certificates shall be delivered to the Engineer.

In determining the quality of plant material, the following elements shall be evaluated:

(a) Root condition.

(b) Plant size (above ground).

(c) Insect and disease free condition.

(d) General appearance (color, shape, prior pruning).

A deficiency in any one (1) or more of these areas shall be sufficient reason to reject selectively or by lot.

Grass seeds shall conform to the requirements of subsection 211.02.03, "Seed."

212.02.04 Handling and Shipping. Plants shall be packed for shipment according to standard practice for the type of plant being shipped. The root system of all plants shall not be permitted to dry out at any time. Plants shall be protected at all times against heat and freezing temperatures, sun, wind, climatic, or seasonal conditions during transit. All plant material shall be furnished in containers unless otherwise specified. All plants specified balled and burlapped (B & B) shall at all times be handled by the ball of earth and not the plant. Broken or "made" balls will not be accepted. Container grown plants shall be well developed with sufficient root development to hold the earth intact after removal from the container without being root bound.

All Group A–1, A–5, and A–15 plants are to be hardened material. This is to be accomplished by storing all plants in the immediate area of planting for a period of not less than three (3) weeks prior to planting. Plants shall be stored in a licensed commercial nursery, or the Contractor may provide equivalent storage and care with written approval of the Engineer.

Prior to moving plants from nursery or storage area to jobsite, they shall be thoroughly sprayed with a solution of an anti-desiccant/anti-transpirant conforming to the following requirements:

The material shall be an anti-desiccant/anti-transpirant in liquid form capable of application by spraying and/or dipping.

Upon drying, the mixture shall produce a gas-permeable, but water retarding, colorless film having an MVT (moisture-vapor-transmission) value of not more than two and five-tenths (2.5). This means that not more than two and five-tenths (2.5) grains of water pass through the film in twenty-four (24) hours at one hundred (100) degrees F. and relative humidity of ninety (90) to ninety-five (95) percent. The procedure for testing shall be as described in ASTM E–96 or Technical Association of the Pulp and Paper Industry publication T464m-45.

Without expense to the Department, two (2) certificates covering anti-desiccant/anti-transpirant material shall be furnished by the manufacturer, certifying that the product complies with the specifications. The certificates shall be delivered to the Engineer in charge at the jobsite at the time of, or prior to, delivery of the order.

212.02.05 Inspection of Plant Material. The Contractor shall inform the Engineer, as soon as practical, of the source of plant material for the project. At the Engineer's option an inspection of all plant materials at the

source may be required prior to shipping of plants from the nursery. This inspection shall coordinate the judgment areas regarding size and quality of plant material between the Highway Department, the Contractor and the nursery. However, there will be no acceptance of any plant material during this inspection.

All plant material will be inspected by the Engineer on arrival at the storage area. This inspection shall determine the acceptance or rejection of the plant material based on quality as specified in subsection 212.02.03, "Quality of Plant Materials." This inspection is for quality of plant material only and does not constitute final acceptance. Plants which are rejected shall be immediately removed from the holding area and replaced by the Contractor at his expense.

All plant material will be continually inspected by the Engineer from the time of arrival at the holding area, during planting and through the plant establishment period. Plants may be individually rejected during this time based on mechanical damage, quality, or physical change of the plant which is not normal to the plant or to the season of the year. Plants which are rejected shall be immediately removed from either the holding area or the project and replaced by the Contractor at his expense.

212.02.06 Substitution of Plants. No substitution of plant material will be permitted unless evidence is submitted in writing to the Engineer that a specified plant cannot be obtained and has been unobtainable since the award of the contract. If substitution is permitted, it can be made only with written approval by the Engineer. The nearest variety, size, and grade as approved by the Engineer shall then be furnished.

212.02.07 Temporary Storage. Plant material delivered and accepted shall be planted immediately. Plants that cannot be planted within one (1) day after arrival shall be "heeled-in" in accordance with accepted horticultural practice, and as follows:

(a) Balled and burlapped plants shall have the root ball protected by moist earth, sawdust, and other acceptable material.

(b) Canned plants shall be placed in and under shelter and kept moist.

Plants stored under temporary conditions shall be protected at all times from extreme weather conditions, and shall be kept moist.

212.02.08 Lumber. Lumber for header boards and plant boxes shall conform to the requirements of Section 718, "Timber."

CONSTRUCTION

212.03.01 Site Preparation. This work shall consist of all work necessary, as set forth in the contract documents, such as roadway construction, drainage facilities, grading, cleaning, etc., to prepare the area for the actual landscaping work. All work as set forth herein shall be completed and approved by the Engineer prior to beginning any preparation of the planting areas.

212.03.02 Layout of Planting. The Contractor will designate, by means

of stakes or other approved markings, the ground location of each random placed plant. Areas of massed or uniform solid plantings shall be marked at their outer extremes only. The Engineer's approval of plant stakeout will be required prior to the commencement of the preparation of planting areas.

In mixed planting areas, trees shall be planted first, followed by the larger shrubs, low shrubs, and the final planting of ground covers.

212.03.03 Preparation of Planting Areas. During the preparation of planting areas, all clods, rocks, or other debris over one (1) inch in largest dimension shall be removed from both cultivated areas and backfill material, and disposed of as directed by the Engineer. In addition thereto, the following requirements will apply:

(a) Planter Boxes. Backfill material shall consist of one (1) part humus to three (3) parts topsoil by volume. This material shall be thoroughly and uniformly mixed before placing in the planter boxes. After placing in the planter box, the material shall be watered until it is completely saturated. Sufficient backfill mixture shall be added and adequately wet so that after settlement has taken place, the material is approximately two (2) inches below the top of the box.

(b) Planting Beds. The soil preparation shall not be initiated until after all grading has been completed and the irrigation system has been installed, tested, adjusted, and accepted by the Engineer. The ground surface within the area shall then be loosened and thoroughly pulverized to a depth of six (6) inches. When required, humus, commercial fertilizer, and other additives shall be incorporated at the rate specified in the contract documents, and shall be thoroughly and uniformly tilled into the soil to a depth of six (6) inches. The area shall then be brought to a plane in conformance to the elevations shown on the plans. The area to be planted shall then be consolidated with approved cultipackers or rollers.

(c) Seed Beds. The soil preparation shall be the same as specified for planting beds.

(d) Planting Holes. Prior to drilling holes, the proposed location of the irrigation lines shall be designated by means of stakes or other approved markings. In the event of conflict between individual planting holes and irrigation lines, the planting holes in question shall be drilled prior to installing the irrigation lines.

All holes shall be drilled with a power auger to the dimensions specified in the contract documents unless otherwise approved by the Engineer. Holes shall be drilled at the location of each individual plant, the stake or marking being considered the center of the hole. The holes shall have vertical walls and horizontal bottoms.

When required, humus, commercial fertilizer, and other additives shall be incorporated at the rates specified in the contract documents and shall be thoroughly and uniformly mixed with the material removed from the holes prior to backfilling. After backfilling the holes, the material shall be saturated with water to the full depth of the hole and until ponding appears in the basin. Sufficient backfill material shall be placed so that after planting and settlement has taken place, the basin will conform to the section as shown in the plans.

Fertilizer starter tablets shall be placed in the backfill mixture of each planting hole at a minimum of four (4) inches and a maximum of eight (8) inches below ground level. The number and size of tablets in each planting hole shall be as specified in the contract documents.

(e) Planting Trenches. Trenches shall be excavated to the dimensions specified in the contract documents and shall be centered on the planting line as staked or otherwise marked.

When required, humus, commercial fertilizer, and other additives shall be incorporated at the rates specified in the contract documents and shall be thoroughly and uniformly mixed with the material removed from the trenches prior to backfilling. After backfilling the trenches, the material shall be saturated with water to the full depth of the trench. Cross checks may be formed as necessary to permit ponding of water during the saturation period but must be removed prior to planting. Sufficient backfill material shall be placed so that after planting and settlement has taken place, the basin will conform to the section as shown in the plans.

212.03.04 Planting. No planting shall be done in any area until the Contractor has received from the Engineer a written statement that the area concerned has been satisfactorily prepared as provided in subsection 212.03.03, "Preparation of Planting Areas."

No more plants shall be distributed within the project area on any one (1) day than can be planted and watered on that day.

Any planting done in soil that is too wet or too dry or not properly conditioned as provided herein will not be accepted. No payment will be made for such planting and any further planting work will be suspended until the Contractor has complied in every way with the specifications.

(a) Plants (Group A). Nursery stakes supporting plants in containers shall be removed and the plants properly pruned as specified herein.

Containers shall be cut, at least twice, from top to bottom and plants shall be removed from the containers in such a manner that the ball of earth surrounding the roots is not broken and they shall be planted and watered as hereinafter specified immediately after removal from the containers. Containers shall not be cut prior to delivery of the plants to the planting areas.

(b) Plants (Group B). Balled and burlapped material shall have all strings or cords cut, and the burlap shall be laid back from the top half of the ball. This shall be done only after the plant is placed in its final position and before completion of the backfill.

(c) Plants (Group C). As soon as each plant is removed from its container, it shall be planted in the prepared planting bed, in a hole previously prepared with a broad, blunt end trowel. The plant shall be carefully lifted with the trowel, inserted in the hole, and the earth shall be gently firmed around it to eliminate air pockets.

Plants brought to the jobsite in plastic or clay pots shall be tapped loose from their containers in such a manner that the ball of earth surrounding the roots is not broken, and then immediately planted. Plants which are brought to the jobsite in peat pots may be planted in the pots, provided the peat fiber is thoroughly wet. Plants which are brought to the jobsite in other cellulose fiber

pots shall have the pots carefully removed by tapping or peeling before planting. No plants brought to the jobsite in flats, pony packs, or bare root will be accepted.

Plants shall be watered as hereinafter specified immediately after planting.

Roots of plants not in containers shall be kept moist and covered at all times and shall not be exposed to the air except while actually being placed in the ground.

Plants shall be set in a plumb position in the backfill mixture material to such a depth that, after the soil has settled, the top of the plant ball will be level with the finished grade.

Plants shall be planted in such a manner that the roots will not be restricted or distorted. Soil shall not be compacted around the roots or ball of the plant during or after planting operations. Any plants which have settled deeper than specified in the above paragraph shall be raised back to the required level, or replaced, at the option of the Contractor.

(d) Plants (Group D). The seed bed shall be in a moist friable condition when seeding is begun. Seeding shall be done as soon as soil conditions allow after the initial watering of the amended soil. Seeding done in soil that is too wet or too dry, or in a condition not generally accepted as satisfactory for lawn seeding will not be accepted. No payment will be made for seeding when the soil condition is considered unsatisfactory and any further seeding work will be suspended until the Contractor has complied in every way with these provisions.

Seed shall be sown from standard mechanical grass seeding equipment with adjustable gate, as appropriate to the area, and at the rate shown on the plans. After sowing, the seed shall be covered by light raking or dragging and seeded areas compacted by rolling. The Contractor shall exercise care to avoid leaving any footprints or other depressions in the compacted seed bed.

Humus mulch shall be evenly applied immediately after the seed bed has been compacted, with manure spreaders, mulch blowers or other approved equipment. Humus shall be spread at the rate of one (1) cubic yard per thousand (1,000) square feet. As soon as mulch is in place, the surface of the seed bed is to be dampened with a fine spray from a nozzle until the mulch is thoroughly moist.

(e) Plants (Group E). The seed bed shall be in a moist, friable condition when seeding is begun. Seeding shall be done as soon as soil conditions allow after the initial watering of the amended soil. Seeding done in soil that is too wet or too dry, or in a condition not generally accepted as satisfactory for lawn seeding will not be accepted. No payment will be made for seeding when soil condition is considered unsatisfactory and any further seeding work will be suspended until the Contractor has complied in every way with these provisions.

Seed shall be sown from standard mechanical grass seeding equipment with adjustable gate, as appropriate to the area, and at the rate shown on the plans. After sowing, the seed shall be covered by rolling. The Contractor shall exercise care to avoid leaving any footprints or other depressions in the compacted seed bed.

212.03.05 Staking and Guying. All staking and guying shall be done concurrently with the planting operation.

(a) Staking. Plants which are to be staked will be specified in the contract documents.

The size, number of stakes, and the depth to be driven shall be as specified in the contract documents, or as approved by the Engineer.

The stakes shall be placed against but not through the plant ball in the case of plants (Groups A and B).

(b) Tree Ties. The method of attaching the ties to stakes and trees shall provide firm connection, as shown in the plans, or as approved by the Engineer. It may, on occasion, as determined by the Engineer, be considered necessary to use No. 10 gage galvanized wire encased in at least one-half (½) inch black rubber hose as tree ties, in which case all connections shall be twisted.

(c) Guying. Plants which are to be guyed will be specified in the contract documents.

All guying shall be done as specified in the contract documents or as approved by the Engineer.

212.03.06 Pruning. Pruning shall be done as determined by the Engineer before plant materials are brought to the jobsite and planting areas.

Pruning of evergreen coniferous plants will not be permitted except under the direction of the Engineer.

Removal of dead leaves from ground cover plants shall be done before these plants are brought to the planting areas.

212.03.07 Watering. If water is available from a new or existing State-owned irrigation system within the limits of the project, it may be obtained from such system free of charge. Where water is not available from such State-owned facility, the Contractor shall make his own arrangements for furnishing and applying water and he shall pay all costs involved.

Valves at meters shall be kept closed at all times, except while the irrigation system is actually in use.

Precautions shall be taken during times when the irrigation system is on to prevent water from wetting vehicles, pedestrians, and pavement. Any erosion, slippage, or settlement of the soil caused by watering shall be repaired by the Contractor at his expense.

Compliance with the provisions in this section shall not relieve the Contractor of his responsibility for his replacement of plants as provided hereinafter.

(a) Plants (Groups A and B). All plants shall be watered immediately after planting. Water shall be applied in a moderate stream until the backfill soil around and below the roots or ball, or earth around each plant, is thoroughly saturated. Where watering is done with a hose, a metal or plastic pressure reducing device approved by the Engineer shall be used. Under no circumstances shall the full force of the water from the open end of a hose be allowed to fall within the basin around any plant.

After the first watering, water shall be applied to all plants as often and in

sufficient amount as conditions may require to keep the soil set above, around, and below the root systems of the plants during the life of the contract. After the installed irrigation system has been accepted, it may be used to water the planted area.

Any additional watering measures required to initially saturate the backfill, water the plants immediately after planting, or to maintain the plants in a satisfactory growing condition shall be anticipated and furnished by the Contractor at his expense.

(b) Plants (Group C). As soon as all the perennials in a given area have been planted, water shall be applied to that area in a fine mist from an atomizing nozzle until the entire planting bed is saturated. This initial watering shall not be done with the installed irrigation system.

After the first watering, water shall be applied to the areas as often and in sufficient amount as conditions may require to keep the soil wet above, around, and below the root systems of the plants during the life of the contract.

(c) Plants (Groups D and E). The seed beds shall be kept in a moist but not soggy condition until after germination. After germination, water shall be applied to the areas as often and in sufficient amount as conditions may require during the life of the contract.

The installed turf irrigation system may be used to water those areas as long as care is taken to prevent erosion or other damage to the area. However, should the irrigation system prove to be unsatisfactory, other means of watering, as approved by the Engineer, shall be used until germination is complete and all grass has attained a height of one (1) inch. After a uniform stand of grass which has attained a height of one (1) inch has been achieved over the entire turf area, the installed turf irrigation system may be used to keep the area moist.

212.03.08 Replacements. (a) Plants (Groups A, B, and C). During the planting and plant establishment period of the project, all plants that show signs of failure to grow normally or which are so injured or damaged as to render them unsuitable for the purpose intended, as determined by the Engineer, shall be removed and replaced in kind. The Engineer will inspect the work on the first or second working day of each week during the planting and plant establishment periods, and will mark or otherwise indicate all plants to be replaced. The Contractor shall complete replacement of such plants as soon as possible, but in no case shall the Contractor take more than two (2) weeks to complete the replacement.

Plants required to replace plants shall be furnished and planted by the Contractor at his expense.

(b) Plants (Groups D and E). The Engineer will inspect the turf at the time of the second cutting and the meadow area when the grass has reached a height of approximately two (2) inches and will designate any areas which need reseeding. Seed used for reseeding shall be the same types and amounts as specified for the initial planting and shall be planted in accordance with the contract documents or as directed by the Engineer. The cost of the seed and actual reseeding shall be borne by the Contractor.

212.03.09 Fertilizers and Additives. When fertilizers or additives are called for, they shall be applied at the rates and as specified in the contract documents or as approved by the Engineer.

212.03.10 Protection of Existing Facilities. Any existing buildings, equipment, piping, pipe covering, sprinkling systems, sewers, sidewalks, landscaping, utilities, roadways, or any other improvement of facilities damaged due to the Contractor's operations shall be repaired or replaced by the Contractor at his expense as directed by the Engineer.

212.03.11 Plant Establishment Work. This work shall consist of watering and caring for all of the plants and planting areas, the replacement of plants, the weeding and general maintenance as specified in the contract documents.

The plant establishment period shall begin at such time as all planting has been accomplished and all other work has been completed and the project is in a neat and clean condition.

The length of the plant establishment period shall be as specified in the contract documents.

The Engineer will notify the Contractor in writing of the start of the plant establishment period and will furnish statements regarding days credited to the plant establishment period after said notification.

The time required for plant establishment work shall be considered as included in the total time limit specified for the contract. Any day upon which no work is required, as determined by the Engineer, will be credited as one (1) of the plant establishment days regardless of whether or not the Contractor performs plant establishment work.

Any day when the Contractor fails to adequately water plants, replace unsuitable or damaged plants, do weed control, adjust or replace bracing and ties, or other work, as determined necessary by the Engineer, will not be credited as one (1) of the plant establishment days. No extension of contract time will be granted beyond the final completion date by reason of failing to perform plant establishment work on days when such work is necessary.

All plants shall be kept watered as provided in "watering" in these standard specifications.

Surplus earth, papers, trash, and debris, which accumulate in the planted areas shall be removed and disposed of in accordance with the provisions in subsection 107.14, "Disposal of Material Outside the Highway Right of Way," and the planted areas shall be so cared for as to present a neat and clean condition at all times.

During the plant establishment period, trees and shrubs shall be pruned or headed back by the Contractor at his expense, when and as directed by the Engineer.

In order to carry out the plant establishment work the Contractor shall furnish sufficient men and adequate equipment to perform the work during the plant establishment period.

METHOD OF MEASUREMENT

212.04.01 Measurement. The quantity of materials and work measured

for payment will be materials and work complete and in place. The various items will be measured in the manner and by the unit as follows:

(a) Site preparation will be measured by the acre.

(b) Topsoil will be measured by the cubic yard in the hauling vehicle at the jobsite.

(c) Preparing soil (plant boxes) will be measured by the square foot.

(d) Preparing soil (plant bed) will be measured by the square foot.

(e) Fertilizer will be measured by the pound determined by marked quantities and sack count, by the ton, all as designated in the proposal.

(f) Humus will be measured by the cubic yard in the hauling vehicle at the jobsite or by the cubic yard determined by marked quantities and sack count.

(g) Mulch will be measured by the cubic yard in the hauling vehicle at the jobsite or by the cubic yard determined by marked quantities and sack count.

(h) Hole preparation will be measured by the actual number of holes prepared.

(i) Trench preparation will be measured by the linear foot and the depth and width of the trench will be designated in the contract documents.

(j) Tree rings will be measured by the number of rings used in the work. Each size will be considered separately and so designated in the proposal.

(k) Mowing strips will be measured by the number of linear feet along the top of the strip.

(l) Planter boxes will be measured by the number of boxes placed on the project that conform to the sizes specified in the contract documents.

(m) Header boards will be measured by the thousand foot board measure (Mfbm).

(n) Plants in Groups A through C will be measured by the number of plants in each group.

(o) Plants in Groups D and E inclusively will be measured by the square foot in place, with each group considered separately.

(p) The unit of measure for plant establishment work will be lump sum.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

212.05.01 Payment. The accepted quantities for items of this section measured as provided in subsection 212.04.01, "Measurement," will be paid for at the contract unit price bid for the type, size, group, or whatever information is necessary for identification, and so identified in the proposal. Such payment shall be full compensation for all the labor, materials, and incidentals necessary to complete the work.

Water and fertilizer tablets will be considered subsidiary to the major items of work and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Site Preparation	Acre
Topsoil	Cubic Yard
Preparing Soil (plant boxes)	Square Foot
Preparing Soil (planting bed)	Square Foot
Fertilizer (type and class)	Pounds, Ton, Each, Gallons
Humus (type)	Cubic Yard
Mulch (type)	Cubic Yard
Hole Preparation	Each
Trench Preparation	Linear Foot
Mowing Strips	Linear Foot
Planter Boxes (type, size)	Each
Header Boards (type lumber, size)	Mfbm
Plants (Groups A–C)	Each
Plants (Groups D–E)	Square Foot
Plant Establishment Work	Lump Sum

SECTION 213

IRRIGATION SYSTEMS

DESCRIPTION

213.01.01 General. This work shall consist of furnishing all materials and labor required to install an irrigation system in accordance with these specifications and the details shown on the plans. The irrigation system as shown on the plans is diagrammatic only, the various components of the system shall be installed so as to provide complete and adequate coverage of the areas to be irrigated.

This work shall also consist of furnishing and installing polyvinyl chloride (PVC) pipe conduit for future irrigation systems as shown on the plans and as specified herein.

MATERIALS

213.02.01 General. All materials and equipment incorporated in the irrigation system shall be new, undamaged, of standard quality, and shall be subject to testing as specified herein. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the applicable requirements of Section 726, "Roadside Materials."

The Contractor shall submit three (3) sets of brochures or shop drawings for each accessory or fixture, and each item of hardware or equipment he intends to use, prior to ordering these items. Brochures shall contain pertinent dimensional, finish, installation, and maintenance data necessary for the proper placement or use of each item. If approved as appearing to meet specification and building requirements, one (1) set of brochures for the item will be returned to the Contractor stamped. Installation of items noted above will not be allowed if pertinent brochures have not been approved unless otherwise approved by the Engineer. The approval of a brochure does not constitute final approval of the item. The Engineer reserves the right to reject any work, material or item that does not conform to the requirements of the plans or specifications as set forth herein even though the pertinent brochure may have been approved.

213.02.02 Bedding and Backfilling. Polyvinyl chloride (PVC) pipe used as conduit shall be bedded and backfilled with sandy material as shown on the plans. Material used for bedding and backfilling of polyvinyl chloride (PVC) pipe conduit shall consist of natural sand or a mixture of sand with gravel, crushed gravel, crushed stone, or other broken or fragmented material to fill the voids in the coarser material. In addition thereto, the material shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
3/8	100
No. 200	0–15

213.02.03 Control Tubing. Control tubing shall be one-quarter (1/4) inch flexible polyvinyl chloride (PVC) conforming to ASTM D 2287. The material shall have a Shore Durometer hardness of eighty-five (85) to ninety-four (94), and a specific gravity of one point forty (1.40) to one point forty-four (1.44).

213.02.04 Automatic Controllers. When called for on the plans, the Contractor shall furnish and install on a concrete base, automatic controllers as herein specified. They shall be an electrically timed device for automatically opening and closing control valves for predetermined periods of time and mounted so that all normal adjustments will be conveniently located for use by the operator. Controllers shall be enclosed in a weatherproof metal housing with hasp and lock or locking device. All locks or locking devices shall be master keyed and three (3) sets of keys provided. Operating features shall include the following:

(a) Each valve in the circuit shall be adjustable for setting to remain open for any desired period of time—from five (5) minutes or less to at least thirty (30) minutes.

(b) The controller shall operate on one hundred ten (110) to one hundred seventeen (117) volts and shall be equipped with a circuit breaker or fuseable connection to protect the controller from overloads.

(c) The controller shall have a master on-off switch to turn all stations off without disturbing the clock settings or automatic timing sequences.

(d) Controls shall allow any position to be operated manually both on or off whenever desired.

(e) Controls shall provide for resetting the start of the irrigation cycle at any time and advancing from one (1) position to another.

(f) Irrigation control conductors shall be copper, UL approved, type UF direct burial cable of the gauge indicated in the contract documents. Any splices made in direct burial cable shall be done with a UL approved kit for that purpose.

213.02.05 Sprinkler Heads. Sprinkler heads shall be of the type, pattern, and coverage shown on the plans.

Soaker valves shall be constructed of polyvinyl chloride (PVC) and shall be of the configuration and dimension shown on the plans. Soaker valves shall be of a make and type of construction so that they may be installed directly in the flexible plastic pipe supply line, and shall have no external working parts. Each soaker valve shall be capable of being adjusted to deliver one (1) to three (3) gallons per hour at ten (10) to twenty (20) p.s.i., final adjustment shall be as determined by the Engineer. Adjustment shall be accomplished with a seven-sixteenths (7/16) inch socket wrench.

213.02.06 Valve Protection Sleeves. Concrete valve protectors shall be precast reinforced Portland cement concrete sleeves with a cast iron lid of the dimensions shown on the plans. Valve protectors shall have extensions as necessary to reach the depth indicated. Extensions shall be made of the same materials as the valve protectors. Valve protectors and extensions may be the product of commercial producers upon prior approval of the Engineer.

213.02.07 Gate Valves. Valves two and one-half (2½) inches and smaller shall be of the same size as the pipes on which they are placed unless otherwise indicated on the plans. Service rating for nonshock cold water shall be two hundred (200) p.s.i.. These valves shall be all bronze, split wedge type, with rising stem and union bonnet. Valves shall have a gland to compress packing, and be provided with backseating to permit repacking the valve under full pressure when it is wide open. Valves shall have either handwheels or malleable iron or cross type handles of brass. Valves two and one-half (2½) inches and smaller shall be threaded and installed with one (1) union on either side of the valve.

Gate valves three (3) inches and larger shall be iron body, bronze mounted, double disc, parallel seat type with "O" ring seal and shall comply with AWWA Standards. These valves shall have a working pressure of two hundred (200) p.s.i. and a test pressure of four hundred (400) p.s.i.. A shut-off rod, six (6) feet in length that will fit a two (2) inch wrench nut, shall be furnished by the Contractor.

213.02.08 Control Valves. Manual control valves shall be straight or angle pattern globe valves of all brass or bronze construction with replaceable compression disks. Manual control valves shall be of the same size as the pipes on which they are placed unless otherwise indicated on the plans, and shall be provided with a union connection. Manual control valves shall be capable of withstanding a cold water working pressure of one hundred fifty (150) p.s.i..

Electric control valves shall be of the diaphragm type, normally closed, twenty-four (24) volt, sixty (60) cycle. The valve solenoids shall operate with eighteen (18) to thirty (30) volts of power. The solenoid shall be completely encapsulated for positive waterproofing. The valve body and bonnet shall be of cast brass or bronze, flange or threaded type. If threaded type is used it shall be provided with a union connection. The time interval between opening and closing the valve shall not be less than five (5) seconds. The solenoid plunger shall be spring loaded so the valve may operate when installed in any position and shall be constructed of stainless steel with neoprene seat. Valve bonnet shall have a bleed screw for manual operation and a manual flow control adjustment. Electric control valves shall be capable of withstanding a nonshock cold water working pressure of one hundred fifty (150) p.s.i..

The soaker irrigation control unit shall consist of a one (1) inch, brass sprinkler control valve, a one (1) inch pressure reducing valve with an adjustable reduced pressure range of zero to fifty (0–50) pounds flow pressure and an integral strainer unit, a pressure gauge with a range of zero to one hundred (0–100) p.s.i. and the necessary fittings to conform to the diagrams shown on the plans.

213.02.09 Quick Coupler Valves. The quick coupler valve shall be of brass or bronze construction with three-fourths (¾) inch F.I.P. bottom connection. The valve shall be of two (2) piece construction with removable upper body. The valve body shall be designed with a single slot to receive a single slot coupler.

The three-fourths (3/4) inch male and one-half (1/2) inch female IPS coupler for the quick-coupler valve shall be single slot of bronze construction.

213.02.10 Valve Boxes. Valve boxes shall be reinforced precast Portland cement concrete boxes of the general dimensions shown on the plans with a steel lid. Valve boxes shall have extensions as necessary to reach the depth indicated. Valve boxes may be the product of commercial producers and may be used upon prior written approval of the Engineer. Extensions shall be of the same material as the concrete valve box.

213.02.11 Backflow Preventers. Backflow preventers shall meet the requirements of the governing agency concerned. Each backflow preventer shall be equipped with a gate valve at each end of the backflow prevention unit. Three (3) inch and larger valves shall be flanged type, iron body, brass trimmed, wedge gate valves with nonrising stem, and shall be capable of withstanding a cold water working pressure of two hundred (200) pounds per square inch. Two and one-half (2 1/2) inch and smaller valves shall be as specified above, except they shall be screwed type and shall be installed with a union between each valve and the backflow prevention unit. Backflow preventers and valves shall be the size shown on the plans.

It will be the responsibility of the Contractor to determine the requirements of the governing agency in regard to the type and detail of backflow prevention required.

For purpose of payment the valves required to be installed at each end of the backflow prevention unit and all fittings between such valves required for proper installation shall be considered as a part of the backflow preventer.

213.02.12 Drain Valves. Automatic ball check drain valve shall be of precision machined brass. Ball checks shall be spring loaded and shall close under a pressure of three (3) p.s.i.. Valves shall be installed with a gravel sump as shown on the plans.

The gravel to be used in gravel sumps for ball check drain valves shall conform to the requirements for Size No. 67 as specified in subsection 706.03.01 of these specifications.

213.02.13 Hose Bibs. The hose bib shall be a no-freeze burial type hydrant with a self-closing handle and shall have three-fourths (3/4) inch male IPS threads at the supply line end.

213.02.14 Vacuum Breakers. When called for in the contract documents or as required by local ordinances, vacuum breakers meeting the following requirements shall be furnished and installed. All vacuum breaker installations are subject to inspection by authorized county or municipal authorities.

Atmospheric vacuum breakers shall have all bronze bodies and be of the same dimension as the pipe on which it is attached. Design shall permit free flow of water under pressure. When vacuum conditions exist it shall automatically close the check valve stopping all flow of water and admit air into the main line. Upon restoration of water pressure the air intake shall be shut off

and the check valve reopened without spillage. Unless otherwise specified, the vacuum breaker shall be installed on the discharge side of the control valve six (6) inches above the highest sprinkler head on the line. Vacuum breakers shall not be required on sprinkler lines when all sprinkler heads on the line are elevated to a minimum of six (6) inches above the finished grade, such as sprinkler lines irrigating shrub beds. Atmospheric vacuum breakers shall have a service rating of one hundred fifty (150) p.s.i. for nonshock cold water and shall be designed for operation up to temperatures one hundred forty (140) degrees Fahrenheit.

Pressure type vacuum breakers shall be installed on the discharge side of the meter or service connection as shown on the plans. Vacuum breakers shall be of heavy duty construction with all bronze bodies, check valves, and test cocks. Pressure type vacuum breakers shall be designed to operate under continuous pressure permitting the free flow of water at all times. Air intake shall be spring loaded to insure positive opening upon release of pressure or vacuum created in the supply lines. Vacuum breakers shall be furnished with approved check valves, inlet and discharge shut-off valves, and field testing cocks. Assembly for various pipe sizes shall be according to local requirements or as specified in the contract documents. Unless otherwise specified pressure type vacuum breakers shall have a service rating of three hundred (300) p.s.i. for nonshock cold water.

All vacuum breaker installations shall meet local ordinances and plumbing requirements.

213.02.15 Air Relief Valve. The air relief valve shall be designed to release air entrapped in a pipeline until liquid reaches the float which will rise to the seat and close the valve. The float shall be stainless steel resting within a stainless steel or bronze cup. The valve body and flange shall be gray iron casting. The valve shall be one (1) inch size with screwed inlet, and shall be capable of withstanding pressures up to three hundred (300) p.s.i.. The valve shall be fitted with a galvanized steel return elbow as indicated on the plans.

CONSTRUCTION

213.03.01 General. The Contractor shall not alter or change the location of pipes, valves, sprinklers, or other equipment as shown on the plans unless so authorized by the Engineer. All necessary arrangements for connecting to mains shall be made by the Contractor with the agency supplying the water, and such installations and equipment shall conform to the requirements set forth by the supplying agency.

213.03.02 Excavation. Trenches shall be of sufficient width to permit snaking of all plastic pipe not connected by rubber ring-type fittings. Pipe connected with rubber ring-type fittings shall not be snaked. The top six (6) inches of topsoil, when such exists, shall be kept separate from subsoil and shall be replaced as the top layer when backfill is made. Trenches shall be excavated with vertical sides and provided with bracing and shoring to be placed as designated by the Engineer. Trenches in rock or like material shall be excavated two (2) inches below the required depth and shall be backfilled to required depth with sand or other suitable material free from rock or stones.

213.03.03 Excavation Adjacent to Trees. Care shall be exercised by the Contractor when excavating trenches near existing trees. Where roots are two (2) inches and greater in diameter, except in the direct path of the pipe, the pipe trench shall be hand excavated and tunneled. When large roots are exposed they shall be wrapped with heavy burlap for protection and to prevent excessive drying. Trenches dug by machines adjacent to trees having roots two (2) inches and less in diameter shall have the sides hand trimmed making a clean cut of the roots. All roots one-half (1/2) inch or greater in diameter that are cut and trimmed shall be treated with an approved tree wound dressing. Trenches having exposed tree roots shall be backfilled within twenty-four (24) hours unless adequately protected by moist burlap or canvas.

213.03.04 Piping. All live main lines shall be a minimum of thirty-six (36) inches below finished grade, measured from the top of the pipe. Other lines shall be a minimum of eighteen (18) inches below finished grade, except flexible soaker lines which shall be four (4) inches below finished grade, measured from the top of the pipe. All water lines, except soaker lines, above thirty-six (36) inch depth shall be provided a means for drainage to prevent freezing. Pipes shall be sloped to drain without sags. Unless otherwise specified, drain valves shall be placed only at the low point of all lateral or section lines. All live mains located under existing pavement shall be placed in conduits jacked under pavement unless otherwise noted on the plans or approved by the Engineer. Conduits shall be no larger than necessary to conveniently accommodate the pipe and fittings. Where necessary, live mains and control tubing may be placed in separate conduits laid adjacent and parallel. All jacking operations shall be performed in a manner approved by the Engineer and conduit run at a depth below the pavement as may be ordered. Where possible, mains and laterals or section piping shall be placed in the same trench.

213.03.05 Jointing. All galvanized steel pipe shall have sound, clean cut standard pipe threads well fitted. All pipe shall be well reamed to the full diameter and burrs removed before assembly. Threaded joints shall be made up with the best quality pure lead paste, applied smoothly and evenly to the male thread only. All screwed joints shall be made tight with tongs and wrenches without the use of handle extensions. Any joints that leak shall be cleaned and remade with new material. Caulking or thread cement to make joints tight will not be permitted.

213.03.06 Blank.

213.03.07 Installation. Conduit shall be installed not less than one and one-half (1 1/2) feet below the curb grade in sidewalk areas and not less than three and one-half (3 1/2) feet below the finished grade in all other areas. Conduit shall be installed under existing pavement by approved jacking or drilling methods. Pavement shall not be disturbed without the approval of the Engineer, and then only in the event obstructions are encountered. When permitted by the Engineer, small test holes may be cut in the pavement to locate obstructions. Jacking or drilling pits shall be kept at least two (2) feet

from pavement edge wherever possible. Excessive use of water that will soften subgrade or undermine the pavement will not be permitted.

Where conduit is installed in an open trench, excavation and backfill shall conform to the provisions in Sections 206, "Structure Excavation," and 207, "Backfill." The conduit shall be laid in the trench to the lines and grades established by the Engineer. The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the conduit. During backfilling operations, the conduit shall be rigidly supported so that no movement of or damage to the conduit or joints will result.

Where connection is made to existing supply lines, compression type fittings may be used.

A backflow preventer shall be installed at each meter if called for on the plans.

Where supply lines or conduits are to be installed through existing paved areas, the subbase, base, and paving removed shall be replaced with material of equal quality.

All pipe shall be cut straight and true. After cutting, the ends shall be reamed out to the full inside diameter of the pipe.

Plastic pipe shall be placed in a trench of six (6) inch minimum width and shall be laid on a two (2) inch layer of sand bedding as shown on the plans. Plastic pipe shall be snaked from side to side in the trench at approximately twenty-five (25) foot intervals. Polyvinyl chloride (PVC) pipe shall be partially backfilled between joints with smaller amounts of backfill material to prevent movement during the pressure test.

Flexible plastic pipe for soaker systems shall be installed and laid according to these specifications, as shown on the plans, by the manufacturer's recommendations, and as directed by the Engineer. When pipe is cut, any burrs shall be removed. The inside surface of the fittings shall be wiped with an approved primer before the cement is applied. The cement used shall be of a type suitable for bonding polyvinyl chloride (PVC) plastic to polyvinyl chloride (PVC) plastic. The cement solution shall be applied freely with a light wiping action to spread the cement uniformly over the pipe surface. The pipe surface shall not be rubbed with the brush or dauber any more than is necessary to spread the cement. If the cement thickens, it shall be discarded and replaced.

The stub ends of each soaker line shall be fitted with any approved threaded polyvinyl chloride (PVC) cap which will facilitate future draining or flushing.

Foreign material shall be prevented from entering the irrigation system during installation. Immediately prior to assembling, all pipes, valves, and fittings shall be cleaned. All unattached ends of pipe, fittings, and valves shall be plugged or capped pending attachment of additional pipe or fittings. All lines shall be thoroughly flushed out prior to attachment of terminal fittings.

Sprinkler connections shall be installed on swing joints as detailed on the plans.

All plastic irrigation pipe shall be installed and laid according to the manufacturer's instructions, and as directed by the Engineer. Before joints of polyvinyl chloride (PVC) plastic pipe are made up, the plastic pipe fittings shall be expose to the same temperature for a reasonable length of time. Pipe shall be cut with a fine-tooth hacksaw and any burrs shall be removed. The

outside surface of the pipe and the inside surface of the fittings shall be cleaned and softened with an approved primer, using a dauber, brush top applicator, or paint brush about one-half (1/2) the pipe diameter. A light second coat of primer shall be applied to the fitting socket. Primer shall not be allowed to run down the inside of the pipe.

The cement solution shall be applied to the pipe and fitting socket with an applicator having a width of approximately one-half (1/2) the diameter of the pipe, using the proper cement for the size of pipe. Apply a full, even layer of cement on the pipe equal to the depth of socket. Flow the cement on with the applicator, do not brush it out to a thin paint type layer. Apply a medium layer of cement to the fitting socket, avoid puddling cement in the socket. On bell end pipe do not coat beyond the socket depth or allow cement to run down in the pipe beyond the bell. Apply a second full even layer of cement on the pipe. Assemble the pipe and fitting without delay, making certain cement is wet. Use sufficient force to ensure that the pipe bottoms in the fitting socket. Twist the pipe one-eighth (1/8) to one-fourth 1/4) turn as it is inserted. Hold the fitting and the pipe together until cement takes its initial set. After assembly a joint shall have a ring or bead of cement completely around the junction of the pipe and fitting. If voids in this ring are present, sufficient cement was not applied and the joint will be considered defective. Using a rag, remove all the excess cement from the pipe and fitting including the ring or bead. Avoid disturbing or moving the joint. Handle newly assembled joints carefully until initial set has taken place. Recommended setting time allowed before handling or moving is related to temperature, type of cement, and size of pipe, and shall be according to manufacturer's recommendations. Old or thickened cement shall be discarded and replaced. The male pipe thread of all threaded connections on polyvinyl chloride (PVC) plastic pipe shall be coated with a joint compound or tape suitable for use on plastic pipe.

Cement solution for flexible polyvinyl chloride (PVC) shall be an approved type for joining flexible polyvinyl chloride (PVC) to itself or to rigid polyvinyl chloride (PVC).

213.03.08 Control Tubing Installation. Control tubing shall be placed with the main supply line. Tubing shall be bundled together by four (4) wraps of friction tape at six (6) foot intervals. Location of the bundle of control tubing shall be to one (1) side of the pipe, and a minimum of two (2) inches from any galvanized pipe.

213.03.09 Flushing and Testing. All main supply lines shall be flushed completely of foreign particles before placing section control valves, quick-coupler valves and hose bibs. After flushing and when valves are in place, all main supply lines shall be tested at one hundred fifty (150) p.s.i. with valves closed. Pressure shall be maintained for a period of eight (8) consecutive hours. All joints showing leaks shall be cleaned, remade, and tested.

After installation of section lines, the piping shall be completely flushed of foreign particles before attaching sprinkler heads and drain valves. After flushing, section lines shall be tested with risers capped and drain valves closed. The test shall be made at maximum operating pressure for a period of one (1) hour. Any pipe, fittings, or joints showing leaks will not be accepted.

All joints showing leaks shall be cleaned, remade, and tested. Control tubing shall be tested in the manner specified hereinbefore for the main supply lines. Tubing shall be flushed for five (5) minutes before connection with the control valves.

Automatic controllers shall be tested by actual operation for a period of two (2) weeks under normal operating conditions. Should adjustments be required, the Contractor shall do so according to manufacturer's direction and test until operation is satisfactory.

213.03.10 Adjusting System. Before final inspection the Contractor shall adjust and balance all sprinklers to provide adequate and uniform coverage. Spray patterns shall be balanced by adjusting individual sprinkler heads with the adjustment screws or replacing nozzles to produce a uniform pattern. Unless otherwise specified, sprinkler spray patterns will not be permitted on pavement, walks, or structures.

213.03.11 Backfill. Backfill shall not be started until all piping has been inspected, tested, and approved by the Engineer, after which, backfilling shall be completed as soon as possible. Upon completion of all piping in the same trench, backfill shall be completed as specified. Trenches containing control tubing shall have a three (3) inch sand or sandy loam cushion free from rocks or stones larger than three-eighths (3/8) inch in diameter placed over all control tubing. Backfill from the bottom of the trench to approximately six (6) inches above the pipe shall be by continuous tamping in such a manner that will not damage pipe or control tubing and shall proceed evenly on both sides of the pipe. The remainder of the backfill shall be thoroughly tamped, except that heavy equipment shall not be used within eighteen (18) inches of any pipe. All backfill material shall be free of rocks, roots, or other objectionable material. The top six (6) inches of the backfill shall be of top soil material or the first six (6) inches of material removed in the excavation.

METHOD OF MEASUREMENT

213.04.01 Measurement. The materials to be measured for payment under these specifications will be listed in the contract items by size, class, type, gage, or whatever information is necessary for identification.

The quantity of pipe and tubing to be measured for payment will be the actual number of linear feet of the type specified complete and in place. Pipe bends, wyes, tees, and other branches will be measured along center lines to the point of intersection.

The quantity of sprinklers, couplers, heads, valves, vacuum breakers, hose bibs, concrete valve boxes, valve assemblies, and riser assemblies will be measured per each of the type and size specified complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

213.05.01 Payment. The accepted quantities of pipe and tubing measured as specified in subsection 213.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

The accepted quantity of all other attachments measured as specified in subsection 213.04.01, "Measurement," will be paid for at the contract unit price bid per each for the types and sizes specified.

Payment per linear foot of conduit involved shall be full compensation for furnishing and installing pipe conduit, bedding and backfilling, caps, markers, and incidentals necessary to install the conduit complete and in place.

The above payment will be full compensation for furnishing all the material and labor necessary to install the system. Such payment shall include excavation, backfill, restoring sidewalk, curb, gutter, pavement, and appurtenances damaged or destroyed by construction and making all required tests.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) (type) Pipe	Linear Foot
(size) (type) (Name of attachment)	Each

SECTION 301

SELECTED MATERIAL BASE OR SURFACE

DESCRIPTION

301.01.01 General. This work shall consist of excavating and placing selected granular materials in one (1) or more courses for base or surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

301.02.01 General. Material shall be as set forth in the special provisions.

CONSTRUCTION

301.03.01 Subgrade Preparation. The surface of the subgrade upon which the selected material is to be placed shall conform to the established lines and grade, shall be reasonably smooth and uniform, and shall be compacted to the required density.

301.03.02 Placing. In producing, handling, and placing selected materials, care shall be taken to prevent segregation of the fine particles from the coarse. When the required compacted thickness is more than six (6) inches the material shall be placed in layers, none of which shall exceed six (6) inches in depth after compaction, except as provided in subsection 301.03.04, "Compaction."

After the material has been uniformly deposited, it shall be thoroughly blademixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the roadbed. It shall then be spread and finished to the required cross section. At the option of the Contractor, selected material may be spread with equipment meeting the requirements of subsection 302.03.03, "Spreading Class B Aggregates."

Binder material, if required, shall be incorporated either in the surfacing aggregate at the plant when the aggregate is produced, or shall be incorporated uniformly on the roadbed in amounts designated by the Engineer.

301.03.03 Watering. Water shall be applied prior to and during all blading operations, to moisten the material sufficiently to prevent segregation of the fine and coarse particles. Water shall also be applied during the compaction and maintenance stages in sufficient amounts to attain compaction and prevent raveling.

301.03.04 Compaction. Compaction shall immediately follow the spreading operation. Where the required thickness is six (6) inches or less, the base course may be spread and compacted in one (1) layer. However, if

vibratory compaction equipment approved by the Engineer is used, and the requirement for the density is complied with, the compacted thickness of any one (1) layer may be increased to eight (8) inches. Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one (1) or more layers by any means to obtain the specified results.

Each layer of material shall be compacted to not less than ninety-five (95) percent of the maximum density as determined by Test Method No. Nev. T101. Test Methods No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

It is to be expected that a loss of density in the upper portions of the material may occur due to the elements, or for a lapse in time, or for other reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed for such recompaction.

METHOD OF MEASUREMENT

301.04.01 Measurement. The quantity of selected material base or surface to be measured for payment will be the number of cubic yards or tons complete and in place.

The weight of material will be determined by deducting from the weight of material delivered to the work, the weight of water in excess of optimum plus one (1) percentage point. Optimum moisture will be determined by Test Methods No. Nev. T101 or T102 as determined by the Engineer. Moisture content will be determined by Test Method No. Nev. T112. The weight of water thus deducted will not be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

301.05.01 Payment. The accepted quantity of selected material base or surfacing, measured as provided above, will be paid for at the contract unit price bid per cubic yard or ton for selected material base or surface, which price shall be full compensation for stripping the pit, crushing, screening, loading, hauling, placing, watering, compacting, and maintaining the base or surface as shown on the plans and as directed by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments may be made in accordance with subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Selected Material Base	Cubic Yard or Ton
Selected Material Surface	Cubic Yard or Ton

SECTION 302

AGGREGATE BASE COURSES

DESCRIPTION

302.01.01 General. This work shall consist of furnishing, placing, and compacting aggregate base courses constructed in accordance with the requirements hereinafter set forth and in reasonably close conformity with the lines, grades, thicknesses, and cross sections shown on the plans or established by the Engineer.

MATERIALS

302.02.01 General. All materials shall conform to the requirements as set forth in the following subsections:

Type 1 Class B Aggregate Base	Subsection 704.03.03
Type 2 Class B Aggregate Base	Subsection 704.03.05
Type 3 Class B Aggregate Base	Subsection 704.03.07
Type 1 Class A Aggregate Base	Subsection 704.03.02
Type 2 Class A Aggregate Base	Subsection 704.03.04
Type 3 Class A Aggregate Base	Subsection 704.03.06

Acceptance sampling will conform to the test requirements as set forth in the above mentioned subsections and in subsection 106.04, "Samples and Tests."

CONSTRUCTION

302.03.01 Subgrade Preparation. Any ruts, holes, defects, or soft yielding places which occur in the subgrade or subbase for any cause whatsoever shall be corrected and compacted to required density and stability before an aggregate base course is placed thereon. The above-mentioned repairs are to be made at the expense of the Contractor, except as provided for in subsection 203.03.02, "Unsuitable Materials."

302.03.02 Spreading Class A Aggregates. The aggregate shall be spread in one (1) operation with a self-propelled spreader ready for compaction without further shaping except for trimming to correct minor deficiencies as hereinafter specified. The spreader shall be provided with a screed that strikes off and distributes the material to the required width and to the surface tolerances hereinafter set forth. The screed shall be adjustable to the required cross section. Screed action includes any cutting, oscillating, or other practical motion that produces a finished surface texture of uniform appearance. The spreader shall be self-propelled and capable of spreading not less than twelve (12) feet in width. Equipment not propelled by the unloading vehicle will be considered self-propelled. In narrow trench widenings, aggregate base course may be placed with self-propelled trench widening spreaders. If the spreader leaves ridges, indentations, or other objectionable marks that cannot be prevented by adjustments or eliminated by rolling, its use shall be discontinued.

The self-propelled spreader shall be equipped with a control system which will automatically control the trimming of the base material to the specified transverse slope and established longitudinal grade. The control system shall be automatically actuated from an independent line and grade control reference through a system of electronically controlled mechanical sensors which will maintain the trimmer screed at the proper transverse slope and at the proper elevation to obtain the required surface. In case of failure of the control system, the trimmer shall be operated by mechanical control only until the material on the roadbed at the time of breakdown is placed.

Motor patrols will not be considered to be self-propelled mechanical spreaders unless they are equipped with end wings on the blade, have the blade locked in a position normal to the direction of travel, and are equipped with cross slope and automatic grade controls that are capable of picking up grade from a wire control, and from an external sensing wheel.

When motor patrols are used, the initial pass for final grade elevation will be controlled by the wire line. Subsequent passes will be controlled by an electronic sensing device capable of maintaining grade.

The Engineer will establish reference points on one (1) side of the roadway at reasonable intervals.

The Contractor shall furnish, place, maintain, remove, and dispose of all materials required to provide continuous line and grade control to the placing machine.

Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one (1) or more layers by any means to obtain the specified results.

Other than previously provided in this subsection, the use of motor graders will not be permitted during depositing, spreading, and compacting operations, except as follows:

(a) Motor graders may be used to correct unavoidable segregation at edges and to trim the surface of the aggregate base after compaction in order to finish the base within the tolerances specified.

(b) When the area of the base is small or irregular, and it is impractical to use self-propelled spreading equipment, the base material may be spread by motor grader or other approved methods.

302.03.03 Spreading Class B Aggregates. The aggregate shall be uniformly deposited on the approved subgrade by means of the hauling vehicle with or without spreading devices. Aggregate shall be distributed over the surface to the depth specified on the plans or established by the Engineer.

After base course material has been deposited, it shall be thoroughly blade-mixed to full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. It shall then be spread and finished to the required cross section by means of a self-propelled pneumatic-tired motor grader.

At the option of the Contractor, the aggregate may be spread with a self-propelled spreader with the aggregate ready for compaction without further

shaping. If this option is exercised, however, the operation shall become subject to the requirements of subsections 302.03.04, "Watering and Mixing Class A Aggregates," and 302.03.02, "Spreading Class A Aggregates."

302.03.04 Watering and Mixing Class A Aggregates. The base course material and water shall be mixed in a mixer approved by the Engineer. Water shall be added during the mixing operation by means of spray bars in the amount necessary to provide the optimum moisture content for compacting. Attention is directed to subsection 210.03.01, "Equipment." After mixing to the extent that the product has a uniform homogeneous appearance, the base material shall be transported to the job while it contains the proper moisture content and shall be placed on the roadbed by means of an approved self-propelled aggregate spreader as provided for in subsection 302.03.02, "Spreading Class A Aggregates." If the material has dried appreciably prior to final compacting, additional water shall be added by means of a pressurized water truck to assist in compaction and to prevent raveling.

302.03.05 Watering Class B Aggregates. Water shall be applied prior to and during all blading and processing operations to moisten the material sufficiently to prevent segregation of the fine and coarse particles. Water shall be applied during the compaction and maintenance stages in sufficient amounts to assist in compaction and prevent raveling. Reference is made to Section 210, "Watering."

302.03.06 Compaction. Compaction shall immediately follow the spreading operation. Where the required thickness is six (6) inches or less, the base course may be spread and compacted in one (1) layer. However, if vibratory compaction equipment of a type approved by the Engineer is used, and the requirement for density is complied with, the compacted thickness of any one (1) layer may be increased to eight (8) inches. Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one (1) or more layers by any means to obtain the specified results. Each layer of material shall be compacted to not less than ninety-five (95) percent of the maximum density as determined by Test Method No. Nev. T101. Test Methods No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

It is to be expected that a loss of density in the upper portions of the material may occur due to the elements, or for a lapse in time, or for other reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed for such recompaction.

302.03.07 Tolerance for Type 2 Class A Aggregate. When a twelve (12) foot straightedge is laid in any direction, the finished surface shall not deviate at any point more than four one-hundredths (0.04) foot from the bottom thereof.

METHOD OF MEASUREMENT

302.04.01 Measurement. The quantity of aggregate base to be measured for payment will be the number of cubic yards or tons complete and in place.

The weight of material will be determined by deducting from the weight of material delivered to the work, the weight of water in excess of optimum plus one (1) percentage point. Optimum moisture will be determined by Test Methods No. Nev. T101 or T102 as determined by the Engineer. Moisture content will be determined by Test Method No. Nev. T112. The weight of water thus deducted will not be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

302.05.01 Payment. The accepted quantity of aggregate base material, measured as provided in subsection 302.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard or ton, for the type and class specified, which price shall be full compensation for stripping the pit, crushing, screening, mixing, hauling, watering, placing, compacting, and maintaining the base courses as shown on the plans and as directed by the Engineer.

It is to be expected that deviations in thickness will occur in placing aggregate base courses. It shall be the inherent responsibility of the Contractor to bring the various base courses to the required grade line. Payment will be limited to the number of tons or cubic yards complete and in place and no additional payment will be made for any labor or equipment used in bringing the courses to grade.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments may be made in accordance with subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Type 1 Class B Aggregate Base	Cubic Yard or Ton
Type 2 Class B Aggregate Base	Cubic Yard or Ton
Type 3 Class B Aggregate Base	Cubic Yard or Ton
Type 1 Class A Aggregate Base	Cubic Yard or Ton
Type 2 Class A Aggregate Base	Cubic Yard or Ton
Type 3 Class A Aggregate Base	Cubic Yard or Ton

SECTION 303

PLANTMIX BITUMINOUS BASE

DESCRIPTION

303.01.01 General. This work shall consist of aggregate and bituminous material mixed in a central plant and spread and compacted on a prepared surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

The requirements of Section 401, "Plantmix Bituminous Pavements—General," shall be applicable to this work, except as hereinafter specified.

MATERIALS

303.02.01 General. The materials shall conform to the requirements as specified in subsections 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements—General."

CONSTRUCTION

303.03.01 General. The construction requirements shall conform to the requirements as specified in subsections 401.03.01 through 401.03.13, inclusive, of Section 401, "Plantmix Bituminous Pavements—General," with the following exceptions:

303.03.02 Rollers. There shall be operating with each paver, three (3) rollers meeting the requirements of (a), (b), and (c) of subsection 401.03.04, "Rollers," except as hereinafter noted.

When two (2) pavers are paving in echelon within four hundred (400) feet of each other and each paver is placing not more than one hundred fifty (150) tons of bituminous mixture per hour, then three (3) rollers meeting the requirements of (a), (b), and (c) of subsection 401.03.04, "Rollers," may be used with both pavers.

303.03.03 Spreading and Finishing. Unless otherwise specified, bituminous plantmix base shall not be placed in courses exceeding five (5) inches in compacted thickness. When more than one (1) course is placed, the courses shall be of approximately equal thickness.

303.03.04 Surface Tolerances. The completed surfacing shall be thoroughly compacted, smooth and free from ruts, humps, depressions, or irregularities. When a straightedge twelve (12) feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than two one-hundredths (0.02) foot from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than two one-hundredths (0.02) foot are present when tested with a straightedge twelve (12) feet long laid in a

direction transverse to the centerline and extending from edge to edge of a twelve (12) foot traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

METHOD OF MEASUREMENT

303.04.01 Measurement. Plantmix bituminous base will be measured as specified in subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

303.05.01 Payment. The accepted quantity of materials measured as provided in subsection 303.04.01, "Measurement," will be paid for at the contract unit price bid per ton for plantmix bituminous base aggregate (type), and per ton for bituminous material (asphalt cement or liquid asphalt).

The above prices shall be full compensation for furnishing all the materials, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous base.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for plantmix bituminous base aggregate may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Plantmix Bituminous Base Aggregate (type)	Ton
Asphalt Cement (grade)	Ton
Liquid Asphalt (grade)	Ton

SECTION 304

PORTLAND CEMENT TREATED BASE

DESCRIPTION

304.01.01 General. This work shall consist of constructing one (1) or more courses of a mixture of aggregate and Portland cement on a prepared surface in accordance with these specifications in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

The method to be used, either plantmix or roadmix, shall be designated in the contract documents.

MATERIALS

304.02.01 General. All material shall conform to the requirements specified in the following sections:

Portland cement	Section 701
Water	Section 722
Aggregate for Portland cement treated base	Subsection 704.03.08
Liquid asphalt	Subsection 703.03.03
Emulsified asphalt	Subsection 703.03.04

At the Contractor's option, cement for Portland cement treated base may be either Type I, Type IP "blended," or Type II Portland cement. The limitation on the amount of alkali in cements used for cement treated base is hereby waived.

CONSTRUCTION

304.03.01 Proportioning. Portland cement shall be applied to the mineral aggregate at not less than two (2) percent nor more than four and one-half (4½) percent of the weight of the dry mineral aggregate. Any allowable variations hereinafter set forth are to be inclusive of the above stated percentages. The exact rate of application of cement shall be as determined by the Engineer. Immediate control of the cement content shall be accomplished by testing the fresh, moist cement aggregate mixture, by Test Method No. Nev. T239.

304.03.02 Mixing—Roadmix Method. (a) Depositing Untreated Aggregate. Untreated aggregate shall be deposited on the prepared area by means of spreader boxes equipped with a readily adjustable strike-off device resulting in a uniform windrow or a uniform spread, to provide the required width and surface tolerance specified in subsection 304.03.06, "Finished Surface." Aggregate to be treated shall not be mixed with roadbed material that is not to be treated.

(b) Mixing. Cement treated base may be mixed either on the roadbed or at a location off the roadbed by the roadmixed method or the plantmixed method as the Contractor may elect.

If the Contractor elects to use the plantmixed method, all the requirements in subsection 304.03.03, "Mixing—Plantmix Method," will apply, except the following:

1. The separation of aggregates into two (2) sizes and storing in separate stockpiles as provided in subsection 304.03.03, "Mixing—Plantmix Method," will not be required.
2. The four-tenths (0.4) of a percentage point variation in the cement content as provided in subsection 304.03.03, "Mixing—Plantmix Method," will be increased to six-tenths (0.6) of a percentage point as specified in this subsection.

If the Contractor elects to use the roadmix method, the roadmixing machine shall be of the pugmill or auger type, or other type meeting the approval of the Engineer. The machine shall be designed to pick up the material to be mixed from the windrow or blanket so that during at least fifty (50) percent of the mixing cycle all the material is picked up and mixed while separated from the mixing table.

Cement to be mixed with aggregate may be furnished in sacks or in bulk. If sacked cement is used, the sacks shall be distributed on the aggregate at the required intervals and then be emptied by hand methods following which the cement from each sack shall be distributed in a layer of uniform thickness. If the cement is furnished in bulk, it shall be spread by mechanical equipment. Each load in the spreading equipment shall be calibrated so the average rate of spread can be determined by the Engineer. The rate of cement spread per linear foot of windrow or blanket shall not vary more than ten (10) percent from the designated rate. The tops of windrowed aggregate shall be flattened or slightly trenched to receive the cement. The distance which cement may be spread upon the aggregate ahead of the roadmixing operations will be determined by the Engineer.

The roadmixing machine shall have provisions for introducing water at the time of mixing, through a metering device or by other approved methods. The water shall be applied by means of controls that will supply the correct quantity of water to produce a completed mixture with a uniform moisture content. Leakage of water from equipment will not be permitted. Care shall be exercised to avoid the addition of any excessive water. The quantity of water added to the mixture will be determined by the Engineer.

Where the material is to be spread and compacted in two (2) or more layers, material for each layer shall be mixed separately.

The resulting mixture shall be uniform and more than one (1) pass of the mixer through the material may be required. If equipment is used that requires more than one (1) pass of the mixer, at least one (1) pass shall be made before any water is added to the material.

At the time mixing is completed the moisture content of the mixture shall not be in excess of one (1) percent over optimum as determined by Test Method No. Nev. T236.

The cement content of samples taken from time to time from the product of the roadmixing machine, or from mixtures spread on the roadbed shall not have a variation above or below the cement content designated by the Engineer or more than six-tenths (0.6) of a percentage point based on the weight of the aggregate as determined by Test Method No. Nev. T239.

The lengths of treated sections shall be regulated to permit completion within the time requirements provided in subsection 304.03.07, "Time Requirements."

Should the Contractor elect to perform roadmixing operations off the roadbed, the provisions specified in this subsection for mixing on the roadbed shall apply.

304.03.03 Mixing—Plantmix Method. (a) General. Cement treated base shall be mixed at a central mixing plant by either batch mixing using revolving blade or rotary drum mixers or continuous mixing at the option of the Contractor. The aggregate and cement may be proportioned either by weight or volume. Aggregate for cement treated base shall be separated into two (2) sizes and each size shall be stockpiled separately. One (1) stockpile shall contain aggregate retained on a No. 4 sieve of which not more than twenty (20) percent shall be finer than a No. 4 sieve. The other stockpile shall contain aggregate of which at least eighty (80) percent is finer than the No. 4 sieve. If aggregates are separated into more than two (2) sizes, any combination of sizes approved by the Engineer that will meet the grading and other test requirements will be acceptable.

In all plants, the water shall be proportioned by weight or volume and there shall be means by which the Engineer may readily verify the amount of water per batch or the rate of flow for continuous mixing. The time of the addition of water or the points at which it is introduced into the mixer, shall be determined by the Engineer.

At the time mixing is completed the moisture content of the mixture shall not exceed optimum as determined by Test Method No. Nev. T236.

In all plants, cement shall be added in such a manner that is uniformly distributed throughout the aggregates during the mixing operation.

The charge in a batch mixer, or the rate of feed to a continuous mixer, shall not exceed that which will permit complete mixing of all the material. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by either a reduction in the volume of material or by other adjustment.

In all plants, the proportioning of materials designated by the Engineer shall be within the following tolerances:

Aggregate weights or rate of feed	±5.0%
Cement content of the complete dry mixture	±0.4%
Moisture content of the completed mixture	±1.0%

The Contractor shall furnish weighing equipment as specified in subsection 109.01, "Measurement of Quantities."

(b) Batch Mixing. In batch type mixers the mixer shall be equipped with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall be accurate to within two (2) seconds. The plant shall be equipped with a suitable automatic device for counting the number of batches.

Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

Cement for each batch shall be weighed on scales separate and distinct from the aggregate batching scales.

If volumetric proportioning is used, means shall be provided for accurately calibrating the amount of material in each measuring bin.

(c) Continuous Mixing. If the continuous type mixer is used, the correct proportion of each aggregate size introduced into the mixer shall be drawn from the storage facility by an approved type of feeder, which will continuously supply the correct amount of aggregate in proportion to the cement, and so arranged that the proportion of each aggregate size can be separately adjusted. The plant shall be equipped with metering devices of an approved type that will introduce the cement and water into the mixer in specified proportions. The metering devices and feeder shall be interlocked and so synchronized as to maintain a constant rate of cement and water into the mixer in specified proportions. The metering devices and feeder shall be interlocked and so synchronized as to maintain a constant rate of cement and water to the aggregate. When storage bins are used, they shall be equipped with overflow chutes for each compartment. A positive signal system shall be provided that will automatically close down the plant when the level of material in any bin approaches the strike-off capacity of the feed gate. The plant shall not be permitted to operate unless the signal system is in good working condition. The feeder for the aggregate shall be mechanically or electrically driven. Aggregate feeders that are mechanically driven shall be directly connected with the drive on the cement feeder. The plant shall be equipped with facilities satisfactory to the Engineer for calibrating gate openings and metering devices by weighing check samples. Aggregate feeders that are electrically driven shall be actuated from the same circuit that serves the motor driving the cement feeder.

Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

The cement feeder shall be equipped with a device by which the rate of cement feed can be determined while the plant is in full operation.

The drive shaft of the cement feeder shall be equipped with a revolution counter reading to one one-hundredth (0.01) of a revolution, and of sufficient capacity to register the total number of revolutions in a day's run.

304.03.04 Spreading. (a) General. The area to be covered with cement treated base shall be prepared and compacted to the grade and cross section for the bottom surface of the cement treated base. Any material cut away in trimming for such grade and cross section shall be disposed of in a manner satisfactory to the Engineer.

Materials mixed at a location off the roadbed shall be protected against moisture loss while being transported to the spreading site, with a method approved by the Engineer, and shall be spread without segregation. Immediately prior to spreading, the area to be covered shall be moistened and kept moist, but not excessively wet.

Where the required thickness is six (6) inches or less, the mixture may be spread and compacted in one (1) layer. Where the required thickness is more than six (6) inches, the mixture shall be spread and compacted in two (2) or more layers of approximately equal thickness and the maximum compacted thickness of any one (1) layer shall not exceed six (6) inches. Work on each layer shall be performed in a similar manner and the surface of the compacted

material shall be kept moist or prevented from drying by some method approved by the Engineer until covered with the next layer.

Cement treated base to be placed in inaccessible areas may be spread by approved methods in one (1) course. After spreading, the material shall be thoroughly compacted to the required lines, grades, and cross sections by means of pneumatic tampers or with other compacting equipment which consistently obtains equal or better compaction than that provided in subsection 304.03.05, "Compaction."

(b) Plantmix Method. The mixture shall be deposited on the roadbed at a uniform quantity per linear foot, which quantity will provide the required compacted thickness without resorting to spotting, picking up, or otherwise shifting the mixture.

When placing material on the mainline, a wire line grade control will be required. On areas other than the mainline, wire line grade control will be optional.

The mixture shall be spread in one (1) operation with a self-propelled mechanical spreader ready for compaction without further shaping. Segregation shall be avoided and the base shall be free from pockets of coarse or fine material. Equipment not propelled by the unloading vehicle will be considered self-propelled. The spreader shall be provided with a screed that strikes off and distributes the material to the required width and to the surface tolerances specified in subsection 304.03.06, "Finished Surface." The screed shall be adjustable to the required cross section. Screed action includes any cutting, oscillating or other practical motion that produces a finished surface texture of uniform appearance. If the spreader leaves ridges, indentations, or other objectionable marks in the surface that cannot be eliminated by rolling, or prevented by adjustments in operation, its use shall be discontinued.

The self-propelled spreader shall be equipped with a control system which will automatically control the placing and trimming of the material to the specified transverse slope and established longitudinal grade. The control system shall be automatically actuated from an independent line and grade control reference on one (1) or both sides of the roadbed. In the event of failure of the control system, spreading operations shall cease until the system is repaired.

Except as otherwise provided in this subsection, the use of motor graders will not be permitted during spreading and compacting operations, except that motor graders may be used to trim the edges and surface of the cement treated base after compaction in order to finish the base within the tolerances specified.

On areas other than the mainline, if wire line grade control is used motor patrols may be used as self-propelled mechanical spreaders.

When motor patrols are used as self-propelled mechanical spreaders, they must be equipped with end wings on the blade, have the blade locked in a position normal to the direction of travel, and shall be equipped with cross slope and automatic grade controls that are capable of picking up grade from a wire control and from an external sensing wheel.

The initial pass for final grade elevation will be controlled by the wire line. Subsequent passes will be controlled by an electronic sensing device capable

of maintaining grade. In the event of failure of the control system, the motor patrol may be operated manually but only until the material on the roadbed at the time of breakdown has been placed.

The Engineer will establish reference points at reasonable intervals on both sides of the mainline. Where wire control is used on other lines, reference points will be established on one (1) side.

The Contractor shall furnish, place, maintain, remove, and dispose of all materials required to provide continuous line and grade control to the placing machine.

In areas of transitions, sharp curves, short runs, or miscellaneous areas where the above methods for control of line and grade are impractical, the method of placement shall be as approved by the Engineer.

The mixed materials shall be spread for the full planned width, either by one (1) spreader or by several spreaders operating in a staggered position across the subgrade, unless otherwise permitted by the Engineer or if traffic conditions require part width construction. Should permission be granted or part width construction be required for the use of one (1) spreader operating alternately on contiguous lanes, not more than one (1) hour shall elapse between the time of placing material in adjacent lanes at any location. If longitudinal construction joints are necessary, they shall fall on lane lines.

304.03.05 Compaction. The provisions contained in this subsection apply to both plantmix and roadmix methods.

Compacting equipment shall produce the required compaction within the operation time limit specified in subsection 304.03.07, "Time Requirements."

Rolling shall be accomplished with a two (2) axle tandem steel roller weighing not less than ten (10) tons, or single or dual drum vibratory roller, and pneumatic-tired rollers which shall conform to the provisions in subsection 401.03.04, "Rollers," of these specifications. The sequence in which these rollers are used shall be as directed by the Engineer.

Rolling shall be performed in such a manner that bumps and irregularities will be eliminated and the finished surface shall be true to the required grade and cross section within the surface tolerances specified in subsection 304.03.06, "Finished Surface."

Water shall be applied without driving equipment over the uncompacted material.

Rolling shall commence from the outer edge of the material, and subsequent rolling shall lap at least twenty-five (25) percent of previously compacted material.

Steel-wheeled rollers shall be used for the finish rolling of each layer. Said "finish" rolling shall commence from the outer edge and progress so as to completely compact the entire surface.

Areas inaccessible to rollers shall be compacted to the required compaction by other means.

The density of compacted cement treated bases shall not be less than ninety-two (92) percent of the maximum density as determined by Test Method No. Nev. T101. Test Methods No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

304.03.06 Finished Surface. The finished surface of cement treated base shall be uniform and shall not deviate at any point more than three one-hundredths (0.03) foot from the bottom of a twelve (12) foot straightedge laid in any direction.

The surface of the finished cement treated base at any point shall not vary more than five one-hundredths (0.05) foot above or below the grade established by the Engineer, except that when Portland cement concrete pavement is to be placed on cement treated base, the surface of the finished cement treated base at any point shall not extend above the grade established by the Engineer.

When the finished surface of cement treated base is outside the specified tolerances and before placing any course of material thereon, all high spots on the finished surface shall be trimmed off to within the specified tolerance. The excess material shall be removed and disposed of in a manner approved by the Engineer immediately after trimming and no loose material shall be left on the base and the area shall then be rolled again. Full compensation for trimming high spots and disposing of the trimmed material shall be considered as included in the prices paid for the contract items involved in constructing the cement treated base and no additional compensation will be allowed therefor.

Cleated equipment shall not be allowed on new cement treated base unless street pads are used on cleats.

304.03.07 Time Requirements. Any mixture of aggregate, cement, and water that has not been compacted shall not be left undisturbed for more than thirty (30) minutes. Not more than two (2) hours shall elapse between the time water is added to the aggregate and cement and the time of completion of initial rolling. Not more than three (3) hours shall elapse between the time water is added to the aggregate and cement and the time of completion of final compaction after trimming.

304.03.08 Construction Joints. At the end of each day's work and when cement treated base operations are delayed or stopped for more than two (2) hours, a construction joint shall be made in thoroughly compacted material, normal to the centerline of the roadbed with a vertical face. Additional mixture shall not be placed until the construction joint has been approved by the Engineer.

Where cement treated base has been finally compacted more than one (1) hour, longitudinal joints shall be constructed by cutting vertically into the existing edge for approximately three (3) inches and the material cut away may be disposed of in the adjacent lane to be constructed. The face of the cut joints shall be moistened in advance of placing the adjacent base.

304.03.09 Protection and Curing. The surface shall be kept moist at all times until the curing seal is applied. Water equipment shall be of a type which will apply moisture in a fog or mist type application free of pressure at the surface being treated.

The completed cement treated base shall be covered with a bituminous curing seal as protection against drying. Curing seal will be required only for the top layer of cement treated base. The surface shall be kept moist until the

seal is applied. Curing seal shall be liquid asphalt, type MC–250, unless otherwise specified, and shall be applied at a rate of between fifteen one-hundredths (0.15) gallon and twenty-five one-hundredths (0.25) gallon per square yard of surface, the exact amount to be determined by the Engineer. The curing seal shall be applied in accordance with the requirements of Section 407, "Seal Coat," and in sufficient quantity to provide a continuous membrane over the base. At the time of application of the curing seal, the surface shall be tightly knit, free from all loose material and shall contain sufficient moisture to prevent excessive penetration of the asphalt. If necessary to insure this, sufficient water to fill the surface voids shall be applied immediately before the asphalt is applied.

The curing seal shall be applied as soon as possible, but not later than twenty-four (24) hours after the completion of final rolling.

Except as hereinafter provided, equipment or traffic shall not be permitted on the cement treated base during the first three (3) days after applying the curing seal, unless otherwise permitted by the Engineer. After traffic is allowed on the cement treated base, and there is danger of excessive surface abrasion, sand blotter may be required as determined by the Engineer. Equipment and traffic shall not be permitted on the cement treated base during the first four (4) days after applying the curing seal when Type IP cement is used.

When equipment or traffic is permitted on the cement treated base and such permission is granted for the sole convenience of the Contractor, he shall protect the curing seal at his expense.

All loose sand shall be completely removed from the cement treated base before any surfacing material is placed thereon. Full compensation for furnishing, spreading, and removing sand as specified above shall be considered as included in the contract price paid for sand blotter and no additional allowance will be made therefor.

304.03.10 Weather Limitations. Cement treated base shall not be mixed or placed while the atmospheric temperature is below thirty-five (35) degrees Fahrenheit, or when conditions indicate that the temperature will fall below thirty-five (35) degrees Fahrenheit for a sustained period of four (4) hours. Cement treated base shall not be placed on frozen ground and all material shall be protected from freezing and frost for a period of five (5) days after placing.

METHOD OF MEASUREMENT

304.04.01 Roadmix Method Designated for Use. The quantity of cement treated base aggregate to be measured for payment will be the number of tons, conforming to all the requirements in the completed work. When aggregate and other materials are mixed at a central mixing plant, the quantity of aggregate will be determined by weighing the completed mixture of aggregate cement and water and deducting from this weight the weight of the cement and water. Water shall be metered and meters shall be calibrated for weight as prescribed in subsection 109.01, "Measurement of Quantities." Mixing, hauling, spreading, and compacting cement treated base will be

measured for payment by the square yard. Area will be determined from horizontal measurement of the finished surface of the base.

Portland cement will be measured for payment by the ton. A barrel of cement will be considered as weighing three hundred seventy-six (376) pounds. Weighing may be done by sack count (ninety-four (94) pounds to the sack) or by scale weights obtained by weighing the spreading equipment before and after spreading the cement when roadmixed, or by scale weights when the mixture is plantmixed.

304.04.02 Plantmix Method Designated for Use. The quantity of plantmix cement treated base aggregate to be measured for payment will be the number of tons, conforming to all the requirements, in the completed work, less the weight of cement. This will be determined by weighing the completed mixture of aggregate, cement and water (in the hauling vehicle prior to delivery), and by deducting from this weight the weight of cement.

Portland cement will be measured for payment by the ton: One barrel of cement will be considered as weighing three hundred seventy-six (376) pounds. Weighing may be done by sack count (ninety-four (94) pounds to the sack) or by scale weights.

304.04.03 General. For both roadmix and plantmix methods, the quantities of liquid asphalt used for curing seal and sand blotter to be measured for payment will be determined as provided in Section 407, "Seal Coat."

The quantity of Portland cement to be measured for payment may be determined from certified weight certificates indicating the truck and trailer number, tare weight, gross weight, net weight, and date. When the measurement of Portland cement is based on certified weight certificates, the following requirements shall apply:

(a) An occasional loaded transporting vehicle shall be weighed by project personnel prior to discharge of any material. The Engineer will determine the frequency in which the loaded vehicles are weighed.

(b) Every empty transporting vehicle shall be weighed by project personnel prior to the vehicle leaving the project.

(c) The Engineer will be the sole judge in determining the quantity of Portland cement used should a discrepancy arise between project weights of the loaded or unloaded vehicles or both and the certified weight certificates.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

304.05.01 Roadmix Method Designated for Use. The accepted quantity of materials measured as provided in subsection 304.04.01, "Roadmix Method Designated for Use," will be paid for at the contract unit price bid per ton for "Portland cement," per ton for "roadmix cement treated base aggregate," and per square yard for "mixing cement treated base."

The above prices shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in constructing roadmix cement treated base, complete in place as shown on the plans and as directed by the Engineer.

The State reserves the right to increase or decrease the estimated amount of cement. Adjustment of unit price will not be made for such increase or decrease.

Payment will be made under:

Pay Item	Pay Unit
Roadmix Cement Treated Base Aggregate (dry)	Ton
Portland Cement for Cement Treated Base	Ton
Mixing Cement Treated Base	Square Yard

304.05.02 Plantmix Method Designated for Use. The accepted quantity of materials measured as provided in subsection 304.04.02, "Plantmix Method Designated for Use," will be paid for at the contract unit price bid per ton for "Portland cement" and per ton for "plantmix cement treated base aggregate," which prices shall be full compensation for stripping the pit, crushing, screening, loading, hauling, furnishing water for the mix, mixing, placing, trimming, and compacting, complete in place as shown on the plans and as directed by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Plantmix Cement Treated Base Aggregate (wet)	Ton
Portland Cement for Cement Treated Base	Ton

304.05.03 General. The accepted quantities of "liquid asphalt" used for curing seal and "sand blotter," will be paid for in accordance with Section 407, "Seal Coat."

For both the roadmix and plantmix methods, all payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for "roadmix cement treated base aggregate" or "plantmix cement treated base aggregate" may be as set forth under subsection 109.06, "Partial Payments."

SECTION 305

ROADBED MODIFICATION

DESCRIPTION

305.01.01 General. This work shall consist of scarifying, pulverizing, mixing, and compacting a mixture of existing base and surfacing material with cement as shown on the plans and as hereinafter specified.

MATERIALS

305.02.01 General. Materials shall conform to the requirements specified in the following sections and subsections:

Portland cement	Section 701
Water	Section 722
Liquid asphalt	Subsection 703.03.03
Emulsified asphalt	Subsection 703.03.04
Sand blotter	Subsection 705.03.06

At the Contractor's option, Portland cement may be either Type I, Type IP "blended," or Type II Portland cement. The limitation on the amount of alkali in cements used for roadbed modification is hereby waived.

305.02.02 Gradation Requirements. The existing bituminous pavement shall be loosened and pulverized to the extent it will conform to the following sieve sizes:

Sieve Sizes	Percentage by Weight Passing Sieve
3 Inch	100
2 Inch	95–100

The percentage of moisture shall not exceed optimum.

CONSTRUCTION

305.03.01 Weather Limitations. Processing for roadbed modification shall not be allowed while the atmospheric temperature is below thirty-five (35) degrees Fahrenheit, or when conditions indicate that the temperature will fall below thirty-five (35) degrees Fahrenheit for a sustained period of four (4) hours within twenty-four (24) hours after final compaction.

The pulverization operation shall not be allowed to proceed when current or anticipated weather conditions will not permit the processing operation to follow due to the temperature limitations specified above.

305.03.02 Preparation of Roadbed. The existing bituminous pavement shall be pulverized full depth.

Once the bituminous pavement has been pulverized as specified, cement shall be spread and the material shall be mixed with a sufficient amount of the existing gravel base to obtain the required depth shown on the plans.

The pulverization operation shall be restricted to one-half (1/2) of the

roadway width at a time. The pulverized material shall, at the Contractor's option, be relaid by one (1) of the following methods and public traffic placed thereon at the end of each working day:

(a) The unprocessed pulverized material shall be relaid and compacted firmly as determined by the Engineer.

(b) The cement may be added, the material processed, spread and compacted, all in conformance with the requirements contained in this section for completion of the finished product.

No more of the existing roadway surface shall be pulverized in any working day than can be relaid as specified above in that working day. The length of one-half (½) of the roadway width that may be pulverized shall not exceed three (3) miles in advance of the completed roadbed modification process at the end of each working day. Only as much Portland cement shall be distributed on the pulverized surface material and base as can be mixed and compacted within the same working day. The finished base shall be sealed within twenty-four (24) hours after final laydown, and until sealed, the base shall be kept moist as directed by the Engineer, at the Contractor's expense.

305.03.03 Proportioning. Portland cement shall be added to the pulverized base and surfacing material at the rate of two (2) percent by weight. The calculated maximum density (as determined by Test Method No. Nev. T101) of the pulverized base and surface material will be used to determine the weight of the material in place. The cement shall be added in a dry state and every precaution shall be taken to prevent blowing. The rate of cement spread shall not vary more than ten (10) percent from the designated rate.

305.03.04 Mixing. The roadmix machine shall be a pugmill type, auger type, or cross-shaft type mixer capable of providing a uniform homogeneous mixture throughout the material to the depth indicated on the plans.

Portland cement to be mixed with the pulverized base and surfacing material may be furnished in sacks or in bulk. If sacked cement is used, the sacks shall be distributed on the pulverized base and surfacing material at the required intervals and emptied by hand methods, following which the cement from each sack shall be distributed in a layer of uniform thickness. If the cement is furnished in bulk, it shall be spread by mechanical equipment. The spreading equipment shall be calibrated so the average rate of spread can be determined by the Engineer. The distance which cement may be spread upon the pulverized base and surfacing material ahead of the roadmixing operation will be determined by the Engineer.

The roadmixing machine shall have provisions for introducing water at the time of mixing, through a metering device or by other approved methods. The water shall be applied by means of controls that will supply the correct quantity of water to produce a completed mixture with a uniform moisture content. Leakage of water from equipment will not be permitted. Care shall be exercised to avoid the addition of any excessive water. The quantity of water added to the mixture will be determined by the Engineer; however, in no case shall the water content in the complete mixture exceed optimum as determined by Test Method No. Nev. T101.

The resulting mixture shall be uniform and more than one (1) pass of the

mixer through the material may be required. If equipment is used that requires more than one (1) pass of the mixer, at least one (1) pass shall be made before any water is added to the material.

305.03.05 Compacting and Finishing. After the materials have been satisfactorily mixed, the mixture shall be bladed and compacted to ninety-five (95) percent relative maximum density as determined by Test Method No. Nev. T101. Test Methods No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer. Compaction shall be accompanied by sufficient blading to eliminate all irregularities.

Rolling shall be accomplished with a two (2) axle tandem steel roller weighing not less than ten (10) tons, or single or dual drum vibratory roller, and pneumatic-tired rollers which shall conform to the provisions in subsection 401.03.04 of the standard specifications. The sequence in which these rollers are used shall be as directed by the Engineer.

Motor patrols shall be equipped with cross slope and automatic grade controls that are capable of picking up grade from an external sensing wheel.

305.03.06 Protection and Curing. The surface shall be kept moist at all times until the curing seal is applied. Water equipment shall be of a type which will apply moisture in a fog or mist type application free of pressure at the surface being treated.

The completed cement treated pulverized base and surfacing material shall be covered with a bituminous curing seal as protection against drying. The curing seal shall be applied as soon as possible but not later than twenty-four (24) hours after completion of final rolling. Curing seal shall be liquid asphalt, Type MC–250, applied at the rate shown on the plans or as directed by the Engineer. The curing seal shall be applied in accordance with the requirements of Section 407 of the standard specifications and in sufficient quantity to provide a continuous membrane over the surface. At the time of application of the curing seal, the surface shall be tightly knit, free from all loose material and shall contain sufficient moisture to prevent excessive penetration of the asphalt. If necessary to insure this, sufficient water to fill the surface voids shall be applied immediately before the asphalt is applied.

Equipment or traffic may be permitted on the cement treated base when approved by the Engineer, after curing seal has been applied. Sand blotter shall be applied as determined by the Engineer.

METHOD OF MEASUREMENT

305.04.01 Measurement. Pulverizing the existing surface will be measured by the mile as indicated on the plans and shall include the preparation of the roadbed, pulverizing, the wetting or drying of the material, and the relaying and compacting. Processing for roadbed modification will be measured by the square yard and shall include the mixing of the materials, the compaction of the mixture, and the finishing of the completed base. Portland cement will be measured for payment by the ton.

One (1) barrel of cement will be considered as weighing three hundred seventy-six (376) pounds. Weighing may be done by sack count (ninety-four (94) pounds to the sack) or by scale weight.

305.04.02 General. The quantity of Portland cement to be measured for payment may be determined from certified weight certificates indicating the truck and trailer number, tare weight, gross weight, net weight, and date. When the measurement of Portland cement is based on certified weight certificates, the following requirements shall apply:

(a) An occasional loaded transporting vehicle shall be weighed by project personnel prior to discharge of any material. The Engineer will determine the frequency in which the loaded vehicles are weighed.

(b) Every empty transporting vehicle shall be weighed by project personnel prior to the vehicle leaving the project.

(c) The Engineer will be the sole judge in determining the quantity of Portland cement used, should a discrepancy arise between project weights of the loaded or unloaded vehicles, or both and the certified weight certificates.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

305.05.01 Payment. The accepted quantities of materials measured as provided in subsection 305.04.01, "Measurement," will be paid for at the contract unit price bid per ton for "Portland cement," per square yard for "processing for roadbed modification" and per mile for "pulverize existing surface," complete in place.

The Department reserves the right to increase or decrease the estimated amount of cement. Adjustment of unit price will not be made for such increase or decrease.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Portland Cement	Ton
Processing for Roadbed Modification	Square Yard
Pulverize Existing Surface	Mile

SECTION 307

SHOULDERING MATERIAL

DESCRIPTION

307.01.01 General. This work shall consist of furnishing and placing shouldering material as shown on the plans and as hereinafter specified.

MATERIALS

307.02.01 General. Water shall conform to the requirements of Section 722, "Water."

307.02.02 Gradation Requirements. Shouldering material shall conform to the following sieve sizes:

Sieve Sizes	Percentage by Weight Passing Sieve
1½ Inch	100
1 Inch	80–100
No. 4	30–65
No. 16	15–40
No. 200	2–12

CONSTRUCTION

307.03.01 Compaction. Shouldering material shall be placed and compacted to the satisfaction of the Engineer.

METHOD OF MEASUREMENT

307.04.01 Measurement. The quantity of shouldering material to be measured for payment will be the number of tons complete in place in the accepted work.

Any water added to the material by the Contractor prior to weighing shall be deducted from the quantity measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

307.05.01 Payment. The accepted quantity of "shouldering material," measured as provided in subsection 307.04.01, "Measurement," will be paid for at the contract unit price bid per ton and shall be full compensation for stripping the pit, crushing, screening, mixing, hauling, placing, watering, compacting, and maintaining the shouldering material as shown on the plans and as directed by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Shouldering Material	Ton

SECTION 401

PLANTMIX BITUMINOUS PAVEMENTS—GENERAL

DESCRIPTION

401.01.01 General. These specifications include general requirements that are applicable to all types of bituminous pavements of the plantmix type irrespective of gradation of aggregate, kind and amount of bituminous material, or pavement use. Deviations from these general requirements will be indicated in the specific requirement for each type.

This work shall consist of one (1) or more courses of bituminous mixture constructed on the prepared foundation in accordance with these specifications and the specific requirements of the type under contract, and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

This work shall also consist of adding mineral filler (hydrated lime or Portland cement) to bituminous mixtures when the item of "mineral filler" appears in the proposal, or as directed.

MATERIALS

401.02.01 Composition of Mixtures. The bituminous plantmix shall be composed of a mixture of aggregate, filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job-mix formula.

Paving operations shall not commence until the following requirements have been complied with:

(a) An approved mix design conforming to the requirements of subsection 705.02.01, "General," of these specifications is received from the Department's Materials and Testing Laboratory.

(b) Based upon the approved mix design, the Contractor shall submit a written proposed job-mix formula for use by the Engineer in setting the job-mix to be used. The proposed formula submitted shall include definite single values for:

1. The percentage of aggregate passing each specified sieve.
2. The percentage of bitumen to be added (to one-tenth (0.1) percent).
3. The temperature of the mixture leaving the mixer.
4. The temperature of the mixture in the hopper of the paving machine.

The job-mix formula with the allowable tolerances shown herein shall conform to the requirements of Section 705, "Aggregates for Bituminous Courses," for plantmix bituminous base aggregate, plantmix bituminous surface aggregate, or plantmix bituminous open-graded aggregate, as the case may be.

The Engineer will determine a job-mix formula with single values for 1, 2,

3, and 4 above and so notify the Contractor in writing. This job-mix formula shall be in effect until modified in writing by the Engineer. The mixture furnished shall conform to this job-mix formula, within the following range of tolerances:

Aggregate passing the No. 4 and larger sieves	±7%
Aggregate passing the No. 8 to No. 100 sieves	±4%
Aggregate passing the No. 200 sieve	±2%
Bitumen content	±0.4% of volume or batch weight of aggregate
Temperature leaving the mixer	±20 deg. F.

The Contractor's job-mix formula shall reflect the values of asphalt percentages recommended by the mix design furnished by the Department's Materials and Testing Laboratory.

Should there be a change in sources of material, a new approved mix design and a new job-mix formula will be established before the new material is used. When unsatisfactory results make it necessary, the Engineer may establish a new job-mix formula and so notify the Contractor in writing.

At the Contractor's option, AR or AC grades of asphalt cement may be used on this project. However, attention is directed to subsection 401.05.01, "Payment," of these specifications.

The temperature of the bituminous material just prior to mixing, and completed mixture in the hauling vehicle just prior to leaving the plant, shall conform to the following tables:

PLANTMIX BITUMINOUS MIXTURES WITH ASPHALT CEMENT

Grade of Asphalt Cement	Bituminous Material		Plantmix Bituminous Base or Surface Mixtures		Plantmix Bituminous Open-Graded Mixtures	
	Min. Temp.	Max. Temp.	Min. Temp.	Max. Temp.	Min. Temp.	Max. Temp.
AR 16,000 or AC 40	275°	400°	275°	350°	275°	290°
AR 8,000 or AC 20	275°	400°	265°	350°	265°	290°
AR 4,000 or AC 10	275°	400°	255°	350°	255°	290°
AR 2,000 or AC 5	275°	350°	245°	350°	245°	275°
AR 1,000 or AC 2.5	250°	325°	220°	325°	220°	275°

The temperature of the completed mixture (when using asphalt cements) at the hopper of the paver shall conform to the following table:

Grade of Asphalt Cement	Plantmix Bituminous Base or Surface Mixtures		Plantmix Bituminous Open-Graded Mixtures	
	Min. Temp.	Max. Temp.	Min. Temp.	Max. Temp.
AR 16,000 or AC 40	255°	350°	255°	290°
AR 8,000 or AC 20	245°	350°	245°	290°
AR 4,000 or AC 10	235°	350°	235°	290°
AR 2,000 or AC 5	225°	350°	225°	275°
AR 1,000 or AC 2.5	200°	325°	200°	275°

PLANTMIX BITUMINOUS MIXTURES WITH LIQUID ASPHALT

Grade and Type MC or SC	Bituminous Material and Mixtures Min. Temp.	Max Temp.
70	95°	140°
250	135°	175°
800	165°	205°
3,000	200°	240°

The completed mixture (when using liquid asphalts) at the hopper of the paver shall not be more than twenty (20) degrees below the specified completed mixing temperature in the hauling vehicle just prior to leaving the plant.

In the event the Contractor elects to change his asphalt source, paving operations shall cease until new aggregate and asphalt samples are submitted and a new mix design is received from the Department's Materials and Testing Laboratory. Further, prior to resuming paving operations, the Contractor must submit and receive approval of a new job-mix formula based on the new mix design.

The type and grade of bituminous material will be specified in the contract. The grade may be changed one (1) grade by the Engineer at no change in unit price.

Attention is directed to subsection 106.04, "Samples and Tests."

401.02.02 Aggregates. Aggregates shall meet the applicable requirements of Section 705, "Aggregates for Bituminous Courses."

401.02.03 Commercial Mineral Filler. Commercial mineral filler shall meet the requirements of subsection 705.03.04, "Commercial Mineral Filler."

401.02.04 Bituminous Materials. The bituminous material shall meet the applicable rquirements of Section 703, "Bituminous Materials." Bituminous material may be conditionally accepted at the source.

401.02.05 Pavement Reinforcing Fabric. The fabric shall meet the requirements of Section 731, "Engineering Fabrics."

CONSTRUCTION

401.03.01 Bituminous Mixing Plant. Sufficient storage space shall be provided for the aggregate, or for each size aggregate, when required. The storage yard shall be maintained neat and orderly and the stockpile, or separate stockpiles, when required, shall be readily accessible for sampling.

Asphalt cement shall be stored in tanks separate and apart from drier burner fuel. The use of tanks with separate compartments that may be used to store two (2) or more products in a single tank will not be permitted for asphalt cement storage unless all of the compartments are filled with the same product.

Burner fuel used for heating aggregates shall be limited to the following types:

(a) Natural gas;
(b) Liquefied natural gas;
(c) Fuel oil (ASTM D 396, Grades No. 1 and No. 2);
(d) Butane;
(e) Propane;
(f) Diesel fuel oil (ASTM D 975, Grades No. 1-D and No. 2-D).

The Contractor shall certify that burner fuels used on the project comply with the foregoing and the Certificate of Compliance shall conform to the requirements of subsection 106.05 of the standard specifications.

The burner used for heating the aggregates shall achieve complete combustion of the approved fuel and shall heat the aggregates sufficiently to achieve acceptable aging of the asphalt. Burner fuel combustion will be considered complete and acceptable aging of the asphalt attained, when "C" (percent of change in asphalt viscosity) in the following formula is equal to or greater than 30:

$$C = \frac{R-A}{B-A} \times 100 \text{ where;}$$

A = Absolute viscosity (Test Method No. Nev. T738A) of original asphalt used in production of the mixture.
B = Absolute viscosity (Test Method No. Nev. T738A) of rolling thin film oven residue for asphalt used in production of the mixture.
R = Absolute viscosity (Test Method No. Nev. T738A) of asphalt from the mixture (Test Method No. Nev. T731B).

Testing to determine "C" will be made whenever the Engineer believes complete combustion may not be occurring. Whenever "C" is less than 30, the Contractor shall stop production and make appropriate adjustments to comply with this requirement before resuming production.

Plants used for the preparation of bituminous mixtures shall conform to all requirements under (a) below. In addition, batch mixing plants shall conform to the requirements under (b); continuous mixing plants (proportioned after drying) shall conform to the requirements under (c); continuous mixing plants (proportioned before drying) shall conform to the requirements under (d); and dryer drum mixing plants shall conform to the requirements under (e).

(a) Requirements for All Plants. Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed bituminous construction.

1. Equipment for Preparation of Bituminous Material. Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring and sampling storage tanks.

2. Drier. The plant shall include a drier or driers which continuously agitate the aggregate during the heating and drying process.

3. Thermometric Equipment. An armored thermometer of adequate

range in temperature reading shall be fixed in the bituminous feed line at a suitable location near the charging valve at the mixer unit.

The plant shall also be equipped with either an approved dial-scale, mercury-actuated thermometer, an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register automatically or indicate the temperature of the heated aggregates.

The Engineer may require replacement of any thermometer by an approved temperature-recording apparatus for better regulation of the temperature of aggregates.

4. Smoke and Dust Control. The Contractor will be required to install satisfactory precipitation devices, or use other methods which will meet local conditions, city, county, and state laws pertinent to air pollution.

5. Truck Scales. Except as allowed in subsection 401.04.01, "Measurement," bituminous mixture shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractor's expense. Such scales shall be platform scales and conform to the provisions of subsection 109.01, "Measurement of Quantities."

6. Safety Requirements. Adequate and safe stairways to the mixer platform and sampling points shall be provided and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a platform or other suitable device to enable the Engineer to obtain sampling and mixture temperature data. A hoist or pully system shall be provided to raise scale calibration equipment, sampling equipment, and other similar equipment from the ground to the mixer platform and return. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed passage shall be maintained at all times in and around the truck loading areas. This area shall be kept free from drippings from the mixing platform.

(b) Requirements for Batching Plants.

1. Plant Scales. Scales shall be accurate to five-tenths (0.5) percent of the maximum load that may be required. Poises shall be designed to be locked in any position to prevent unauthorized change or position. In lieu of truck scales, the Contractor may provide an approved automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load.

The amount of filler material shall be determined by weighing on springless dial scales separate from the plant weigh hopper or by some method that uniformly feeds the mixer within ten (10) percent of the required amount.

2. Feeder for Drier. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained.

3. Screens. Plant screens capable of screening all aggregates to the specified sizes and proportions will be required when the aggregate is proportioned after the drying operations. Plant screens may be eliminated when proportioning is done prior to the drying process and the aggregate is proportioned in accordance with subsection (d)(2), "Aggregate Proportion-

ing," of this subsection and prepared in accordance with the first paragraph of subsection 401.03.08, "Preparation of Aggregates."

4. Bins. The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for mineral filler when used and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with its individual outlet gate, constructed so that when closed there shall be no leakage. The gates shall cut off quickly and completely. Bins shall be so constructed that samples can be readily obtained.

5. Weigh Box or Hopper. The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

6. Bituminous Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.

7. Bituminous Control. The equipment used to measure the bituminous material shall be accurate to plus or minus five-tenths (0.5) percent. The bituminous material bucket shall be a nontilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be not less than three-fourths (3/4) the length of the mixer and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve or valves, and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least fifteen (15) percent in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated quick-acting, nondrip, charging valve located directly over the bituminous material bucket.

Bituminous material shall be measured by means of springless dial scales or metering devices. Springless dial scales shall have a capacity of not more than one thousand (1,000) pounds in two (2) pound gradations.

The indicator dial shall have a capacity of at least fifteen (15) percent in excess of the quantity of bituminous material used in a batch. The controls shall be constructed so that they may be locked at any dial setting and will automatically reset to that reading after the addition of bituminous material to each batch. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over. All of the bituminous material required for one (1) batch shall be discharged in not more than fifteen (15) seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the

spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

8. Mixer. The batch mixer shall be of a twin pugmill type, steam jackets, or heated by other approved means and capable of producing uniform mixtures within the specified tolerances. It shall be equipped with a sufficient number of paddles or blades set in proper order and operated at such speed as to produce a properly and uniformly mixed batch. The clearance of the paddles or blades from all fixed and moving parts shall not exceed one (1) inch. Badly worn or defective paddles or blades shall not be used in mixing operations.

9. Control of Mixing Time. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry mixing period and shall lock the mixer gates throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the start of introduction of bituminous material. The wet mixing period is the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.

The mixer shall be equipped with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall measure the time of mixing within an accuracy of two (2) seconds. A suitable automatic device for counting the number of batches shall be provided and maintained in proper working condition.

When the aggregates and the bituminous material have been combined, the entire mass shall be mixed in an approved mixer. The mixing shall continue until homogeneity and a uniform coating are achieved. The output rate shall not exceed the manufacturer's capacity rating.

(c) Requirements for Continuous Mixing Plants (Proportioned After Drying).

1. Feeder for Drier. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained.

2. Screens. Plant screens capable of screening all aggregates to the specified sizes and proportions will be required.

3. Bins. The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for mineral filler when used and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with its individual outlet gate. Bins shall be so constructed that samples can be readily obtained. Bins shall be equipped with adequate telltale devices to indicate the position of the aggregates in the bins at the lower quarter points.

4. Aggregate Proportioning. The plant shall include a means for accurately proportioning each size of aggregate after the drying operation.

The plant shall have a mechanical feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive means. Indicators shall be provided for each gate to show the respective gate opening.

A meter for determining the rate of each feeder, or a revolution counter, shall be provided.

Commercial filler material introduced into the mixer shall be drawn from storage bins by a continuous mechanical feeder which will uniformly feed the mixer within ten (10) percent of the required amount.

5. Weight Calibration of Aggregate. The plant shall include a means for calibration of each aggregate feeder by weighing test samples. Contractor shall provide accurate scales and test boxes for this weight calibration.

6. Bitumen Metering Device. The bituminous material shall be introduced into the mixer through a gallonage meter by a positive displacement metering device. This metering device shall be equipped with a ready means of varying the bituminous material delivery rate.

7. Synchronization of Aggregate Feed and Bituminous Material Feed. Satisfactory means shall be provided to afford a positive interlocking control between the flow of each feeder and the flow of bituminous material. The interlocking control shall indicate a visible or audible signal when the level of material in any one (1) feeder approaches the strike-off capacity of the feed gate, or shut the plant down.

8. Mixer. The plant shall include a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture within the job-mix tolerances. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. Charts shall be provided showing the rate of feed of aggregate per minute for the aggregate being used.

9. Surge Bins. The plant will be equipped with an approved surge bin at the discharge. This surge bin will be in excess of twenty (20) tons and shall be equipped with an approved surge batcher or other approved method satisfactory to the Engineer that will prevent segregation of the bituminous mixture as it is being discharged into the hauling vehicle.

(d) Requirements of Continuous Mixing Plants (Proportioned Before Drying).

1. Aggregate Stockpiles. The first paragraph of subsection 401.03.08, "Preparation of Aggregates," shall apply.

2. Aggregate Proportioning. The plant shall include a means for accurately proportioning each size of aggregate prior to the drying operation. Each compartment bin shall be separated by a vertical divider of adequate height to prevent aggregate spillover from adjacent bins. In addition, each bin shall have an accurate method of regulating and measuring the material being drawn from the bin. Indicators shall be provided for each bin to show respective feed rates.

Commercial filler material introduced into the mixer shall be drawn from

storage bins by a continuous mechanical feeder which will uniformly feed the mixer within ten (10) percent of the required amount.

3. Weight Calibration of Aggregate. The plant shall include a means for calibration of each aggregate feeder by weighing test samples. The Contractor shall provide accurate platform scales and test boxes (having a capacity of not less than ten (10) tons) for this purpose. Prior to beginning the plantmix operation, and any other time the Engineer may deem necessary, the Contractor shall calibrate the aggregate feed so the weights shown on the console indicators are within one (1) percent of the actual weight as weighed on the sealed platform scales. This calibration procedure shall be observed and approved by a State representative.

4. Bitumen Metering Device and Calibration. The bituminous material shall be introduced into the mixer through a gallonage meter by a positive displacement metering device. This metering device shall be equipped with a ready means of varying the bituminous delivery rate. Prior to beginning the plantmix operation, and any other time the Engineer may deem necessary, the Contractor shall calibrate the bitumen feed so the weights or gallons shown on the indicators are within one (1) percent of the actual weight as weighed on the sealed platform scales. The vessel used for the calibration shall have a capacity not less than one thousand (1,000) gallons. The vessel and platform scales shall be furnished by the Contractor. This calibration procedure shall be observed and approved by a State representative.

5. Synchronization of Aggregate Feed and Bituminous Material Feed. Satisfactory means shall be provided to afford a positive interlocking control between the flow of each feeder and the flow of bituminous material. The interlocking control shall indicate a visible or audible signal when the level of material in any one (1) feeder approaches the strike-off capacity of the feed gate, or shut the plant down.

6. Mixer. The plant shall include a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture within the job-mix tolerances. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. Charts shall be provided showing the rate of feed of aggregate per minute for the aggregate being used.

7. Surge Bins. The plant will be equipped with an approved surge bin at the discharge. This surge bin will be in excess of twenty (20) tons, and shall be equipped with an approved surge batcher or other approved method satisfactory to the Engineer that will prevent segregation of the bituminous mixture as it is being discharged into the hauling vehicle.

(e) Requirements for Dryer Drum Mixing Plants.

1. Aggregate Stockpiles. The first paragraph of subsection 401.03.08, "Preparation of Aggregates," shall apply.

2. Aggregate Proportioning. The plant shall include a means for accurately proportioning each size of aggregate prior to the drying operation. Each compartment bin shall be separated by a vertical divider of adequate height to prevent aggregate spill-over from adjacent bins. In addition, each bin shall have an accurate method of regulating and measuring the material being

drawn from the bin. Indicators shall be provided for each bin to show respective feed rates.

Commercial filler material introduced into the mixer shall be drawn from storage bins by a continuous mechanical feeder which will uniformly feed the mixer within ten (10) percent of the required amount.

3. Weight Calibration of Aggregate. The plant shall include a means for calibration of each aggregate feeder by weighing test samples. The Contractor shall provide accurate platform scales and test boxes having capacity of not less than ten (10) tons for this purpose. Prior to beginning the plantmix operation, and any other time the Engineer may deem necessary, the Contractor shall calibrate the aggregate feed so the weights shown on the console indicators are within one (1) percent of the actual weight as weighed on the sealed platform scales. This calibration procedure shall be observed and approved by a State representative.

4. Bitumen Metering Device and Calibration. The bituminous material shall be introduced into the mixer through a gallonage meter by a positive displacement metering device. This metering device shall be equipped with a ready means of varying the bituminous delivery rate. Prior to beginning the plantmix operation, and any other time the Engineer may deem necessary, the Contractor shall calibrate the bitumen feed so the weights or gallons shown on the indicators are within one (1) percent of the actual weight as weighed on the sealed platform scales. The vessel used for the calibration shall have a capacity not less than one thousand (1,000) gallons. The vessel and platform scales shall be furnished by the Contractor. This calibration procedure shall be observed and approved by a State representative.

5. Synchronization of Aggregate Feed and Bituminous Material Feed. Satisfactory means shall be provided to afford a positive interlocking control between the flow of each feeder and the flow of bituminous material. The interlocking control shall indicate a visible or audible signal when the level of material in any one (1) feeder approaches the strike-off capacity of the feed gate, or shut the plant down.

6. Mixer. The plant shall include a mixing device which will obtain homogeneity and a uniform coating. The mixing output shall not exceed the manufacturer's capacity rating.

7. Surge Bins. The plant will be equipped with an approved surge bin at the discharge. This surge bin will be in excess of twenty (20) tons, and shall be equipped with an approved surge batcher or other approved method satisfactory to the Engineer that will prevent segregation of the bituminous mixture as it is being discharged into the hauling vehicle.

401.03.02 Hauling Equipment. The bituminous mixture shall be discharged from the surge bins directly into the hauling vehicle and the material shall be transported directly to the jobsite paving operation. Stockpiling of the bituminous mixture outside the surge bins and ultimately loading into the hauling vehicles is strictly prohibited.

Trucks used for hauling bituminous mixtures shall have tight, clean, smooth, metal beds which have been thinly coated with a minimum amount of paraffin oil, lime solution, or other approved material to prevent the mixture from adhering to the beds.

401.03.03 Pavers. Bituminous pavers shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous plantmix material in lane widths applicable to the specified typical section and thicknesses shown on the plans. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plantmix material in widths shown on the plans.

Pavers shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

The screed shall be equipped with automatic controls which will make adjustments in both transverse and longitudinal direction. The external longitudinal reference devices used to pick up grade information for the automatic sensing control shall conform to the following requirements:

(a) When picking up grade information from an underlying base, the external longitudinal reference device shall not be less than thirty (30) feet in length. The devices for averaging the high and low spots over a minimum thirty (30) foot span shall be a floating beam or a long ski.

(b) When picking up grade information from an adjacent compacted pavement course or a concrete surface, the external longitudinal reference device shall not be less than ten (10) feet in length.

Sensing grids or shoes for monitoring the grade information from these longitudinal reference devices shall ride approximately in the middle portion. The pathways for the external reference devices shall be kept clear of pebbles, debris, and any other obstruction that might affect the pavement surface.

Should the automatic controls fail to function properly, the Engineer may permit the Contractor to finish the half shift with manual controls. Operations shall not resume until the controls are repaired.

401.03.04 Rollers. Rollers shall meet the following requirements:

(a) Breakdown rollers shall be either a three (3) wheeled steel roller or a two (2) axle tandem or a three (3) axle tandem weighing not less than ten (10) tons.

(b) Except as hereinafter permitted, pneumatic-tired rollers shall consist of not less than nine (9) wheels equipped with pneumatic tires of equal size and diameter mounted on two (2) axles attached to a rigid frame equipped with a loading platform or body suitable for ballast loading; so that the total weight of the roller can be varied to produce an operating weight per tire of between one thousand (1,000) and two thousand (2,000) pounds. The tires shall have treads satisfactory to the Engineer. The tires on the rear axle shall be so spaced that the entire gap between adjacent tires on the front axle will be covered by one (1) tread of the following tires. The tires shall be uniformly inflated so that the air pressure in the several tires will not vary more than five (5) pounds per square inch. Inflation pressure in pounds per square inch shall be the tire manufacturer's recommendation. Minimum tire size shall be 7.50 x 15 inches, four (4) ply. The use of pneumatic-tired rollers with a lesser

number of wheels and a greater maximum operating weight per tire than that specified herein will be permitted subject to the following requirements:

1. The minimum width between the outer edge of the outside tires on a given axle shall be sixty (60) inches.

2. The weight of the roller and the tire pressure can be varied to produce a ground contact pressure between fifty (50) and seventy (70) p.s.i.

(c) The finish roller shall be a two (2) axle tandem weighing not less than eight (8) tons.

Attention is directed to subsection 401.03.11, "Rolling."

401.03.05 Weather Limitations. Plantmix bituminous base or surface shall not be placed on any wet surface, or when the temperatures are less than those specified in the following tables, or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures:

NOTE: Prior to paving, **both** atmospheric and surface temperature limitations must be complied with.

Atmospheric Temperature Limitations:

Compacted Thickness	Item No. 402 Surface Courses	Item No. 303 Base Courses
Less than 1"	55° F.	40° F.
1" to 2"	45° F.	35° F.
Greater than 2" to 3"	35° F.	35° F.
Greater than 3"	Does Not Apply	25° F.*

*Only on dry surface, not frozen, and when air temperature is rising.

Surface Temperature Limitations:

Plantmix bituminous base or surface shall not be placed on any surface until the surface to be covered is a minimum of fifty (50) degrees Fahrenheit.

The open-graded plantmix surface shall be placed only when the atmospheric temperature in the shade and the pavement surface temperature are above sixty (60) degrees Fahrenheit.

401.03.06 Preparation of Existing Surface. When the surface of the existing pavement or old base is irregular, it shall be brought to uniform grade and cross section as directed.

When specified in the contract, all longitudinal and transverse joints and all cracks shall be sealed by the application of an approved joint sealing compound before spreading the mixture upon a Portland cement concrete surface. All excess bituminous material shall be removed from joints and cracks prior to spreading the mixture.

Contact surface of curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of asphaltic emulsion prior to the bituminous mixture being placed against them.

401.03.07 Preparation of Bituminous Materials. The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature at all times.

401.03.08 Preparation of Aggregates. Aggregates proportioned prior

to the heating and drying process shall be separated into two (2) general sizes: (1) that portion of the material having a minimum of eighty (80) percent passing a No. 4 sieve, and (2) that portion of the material having a minimum of eighty (80) percent retained on a No. 4 sieve. The material shall be maintained within these limits with a uniformity of plus or minus five (5) percent. Each portion of the material shall be stored separately. When moving the aggregate from storage to compartment bins, any method may be used which will not cause segregation, degradation, or combinations of aggregate which fail to meet the specified gradation requirements. Plantmix operations shall not commence until a minimum of five thousand (5,000) tons combined has been separated and stockpiled, unless the tonnage required is less than five thousand (5,000) tons.

Aggregates proportioned immediately after the heating and drying process shall be screened into a minimum of two (2) fractions in the case minus one-half (1/2) inch aggregate is used, and into a minimum of three (3) fractions when larger sized aggregate is used. The screened material shall be conveyed to separate compartments ready for proportioning and mixing with bituminous material. Plantmix operations shall not commence until a minimum of five thousand (5,000) tons has been stockpiled, unless the tonnage required is less than five thousand (5,000) tons.

When the required tonnage is more than five thousand (5,000) tons, then a minimum of five thousand (5,000) tons shall be maintained in the stockpile until such time as five thousand (5,000) tons or less are needed to complete the plantmix operations. The aggregates shall be placed in the cold feed proportioning bins directly from the stockpile. Charging of the cold feed bins from the crushing plant is prohibited.

Hydrated lime or Portland cement (hereinafter referred to as mineral filler) shall be added to the plantmix bituminous base, surface, and open-graded surface aggregates at the minimum rate of one (1) percent by weight of aggregate, prior to adding the bituminous material.

The method of handling and proportioning the mineral filler shall be as follows:

Requirements for Batching Plants. Mineral filler for each batch shall be accurately weighed to within ten (10) percent of the required amount. The mineral filler may be introduced through the weigh hopper or fed directly into the mixer. If the weigh hopper is used, the plant scales must be sensitive enough to supply the mineral filler within specified tolerances. In addition, all movement of the hopper must subside prior to addition of the mineral filler. If the mineral filler is fed directly into the mixer, a separate springless dial scale shall be utilized. Regardless of the introduction system used, it shall be approved, prior to use, by the Engineer.

Requirements for Continuous and Dryer-Drum Mixing Plants. Mineral filler shall be drawn from a storage facility in which the mineral filler is agitated by air or other means to keep it in a uniform free flowing condition. The mineral filler for delivery to the mixer shall be from a vane type metering device which is interlocked (electric driven feeders shall be actuated from the same circuit) to the flow of each aggregate feeder and flow of bituminous material. The drive shaft on the mineral vane feeder shall be equipped with a

revolution counter reading to one-tenth (0.1) of a revolution, and a means for varying the rate.

Mineral filler delivered to a standard continuous type mixing plant shall be introduced at the intake end of the pugmill. Mineral filler shall be introduced by an approved method when a drum-mixing plant is used.

401.03.09 Mixing. The permissible moisture content of the bituminous mixture just behind the paver shall not exceed one and one-half (1½) percent as determined by Test Methods No. Nev. T112 (Method A) or T306. Test method to be determined by the Engineer. Should the aggregate contain excessive moisture when heated within the temperature limits, the Contractor will be required to take satisfactory corrective action before resuming plant-mix operations.

The dried aggregate shall be combined in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. The bituminous mixture shall be measured or gauged and introduced into the mixer in the amount specified by the job-mix formula.

Commercial filler material, when required, shall be added to the mixer separately and shall be thoroughly dry. If the materials are mixed in a batching plant, the filler material shall be fed directly into the mixer as near the center as possible.

When the aggregates and the bituminous material have been combined, the entire mass shall be mixed in an approved mixer. The mixing shall continue until homogeneity and a uniform coating are achieved. The output rate shall not exceed the manufacturer's capacity rating.

Should the mixture, at the plant or in place, show an excess or deficiency of bitumen, show injury or damage due to burning or overheating, or show an improper combination of aggregates, due to the Contractor's failure to conform to specification requirements, it shall be rejected and if still in the truck shall be disposed of as directed. If an unsatisfactory mix, as referred to above, has been placed, it shall be disposed of and replaced as directed. No compensation will be allowed for rejected material.

401.03.10 Spreading and Finishing. Each course of the plantmix bituminous surface shall be placed full width. As the work progresses, the Contractor may advance any portion of this course only to the extent of one (1) day's operation prior to beginning work on a succeeding width, and the course shall be completed to its full plan width prior to any general longitudinal advancement beyond the width first placed. In the event that the work of placing plantmix bituminous surface is to be suspended for more than one (1) day, all portions of the course shall be brought to as near the same point as practicable prior to suspending paving operations unless otherwise ordered by the Engineer.

The Contractor's hauling equipment shall not be permitted to turn in areas where such turning may result in tearing, gouging, or distortion of the edges of a previously laid pad of bituminous material.

Should turning movements of the Contractor's equipment result in tearing, gouging, or distortion of a previously laid pad of plantmix bituminous base or surface, such turning movements shall be immediately discontinued and all

damage shall be repaired at the Contractor's expense as directed by the Engineer.

The mixture shall be laid upon an approved surface, spread and struck off to grade, and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

The forward rate of travel of the paving machine(s) shall be regulated to a speed dependent upon the capacity of the mixing plant to furnish the mixture. The machine(s) shall move at a uniform rate with a minimum amount of stopping.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked, and luted by hand tools. For such areas, the mixture shall be dumped, spread, and screed to give the required compacted thickness.

The Contractor may windrow plantmixed bituminous base or surface material in front of the spreading and finishing machine, provided that the following conditions and requirements are strictly adhered to:

(a) The windrow is properly sized, thereby insuring the delivery of the correct amount of material to the spreading and finishing machine at all times.

(b) The bituminous mixture shall be transferred from the windrow to the spreading and finishing machine in such a manner that the materials in the spreading machine will be a uniform mixture. The base, upon which the windrow was formed, shall not be disturbed and there shall be no excess paving material remaining on this base between the pickup device and the spreading and finishing machine.

(c) The minimum temperature requirements pertain to the material in the hopper of the spreading and finishing machine. Plantmix bituminous mixture that does not meet the minimum temperature specified shall not be incorporated in the work but shall be wasted in a manner satisfactory to the Engineer.

Should any course of bituminous mixture placed by utilizing a windrow be inferior, as determined by the Engineer, to that placed by transferring the bituminous mixture directly from the hauling vehicle to the spreading machine, the use of a windrow shall be discontinued.

401.03.11 Rolling. Rolling patterns shall be as directed by the Engineer. The initial or breakdown rolling shall consist of two (2) complete coverages of the bituminous mixture. Initial rolling shall commence at the lower edge and shall progress toward the highest portion of the roadbed. Under no circumstances shall the center be rolled first, nor at any time will the guide roll be allowed to lead on the initial pass in either direction. The initial or breakdown rolling shall be followed by a minimum of three (3) complete coverages with a pneumatic-tired roller while the internal temperature at mid-depth of the pad is at or above one hundred eighty (180) degrees Fahrenheit. The final rolling of the bituminous mixture shall be performed with a two (2) axle tandem roller. The sequence of rolling may be modified to provide breakdown rolling with a two (2) axle tandem or pneumatic-tired roller and final rolling with a three (3) axle when directed. Rolling shall be performed in a manner that cracking, shoving, or displacement will be avoided. All rollers shall be in

good condition, and the reversing mechanism so maintained that the roller is capable of changing directions smoothly. The roller shall be kept in continuous motion while rolling so that all parts of the pavement shall receive equal compression. The motion of the roller shall be slow enough at all times to avoid displacement of the pavement. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected immediately by the use of rakes and fresh mixture when required. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened.

401.03.12 Joints. Placing of the bituminous paving shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Engineer. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course and form a clean, vertical edge. A brush coat of asphaltic emulsion shall be used on contact surface of transverse joints just before additional mixture is placed against the previously rolled material.

Longitudinal joints shall be spaced in such a manner that joints in succeeding courses will be at least six (6) inches horizontally from joints in any preceding course.

Attention is directed to subsection 401.03.10, "Spreading and Finishing."

401.03.13 Surface Tolerances. Surface tolerances will be specified under the respective sections of bituminous pavement.

401.03.14 Surfacing Miscellaneous Areas. Areas which may be included in this work are as follows:

Surfacing of road and driveway approaches, median strip areas, island areas, sidewalks, dikes (excluding plantmix shoulder dikes), gutters, gutter flares, ditches, downdrains, spillways, aprons at the end of drainage structures, and other designated areas outside the travelled way shall conform to the provisions specified in this subsection.

The amount of bituminous material used in the bituminous mixture placed in dikes, gutters, gutter flares, downdrains, spillways, aprons at the end of drainage structures, and other designated areas outside the travelled way shall be increased not less than one (1) percent by weight of the aggregate over the amount of bituminous material used in the bituminous mixture placed on the travelled way. Submittal of a revised job-mix formula will not be necessary.

The bituminous mixture placed in median strip areas, island areas, sidewalks, dikes, gutters, gutter flares, ditches, downdrains, spillways, aprons at the ends of drainage structures, and other designated areas outside the travelled way may be spread in one (1) layer. The material shall be compacted to the required lines, grades, and cross section.

Dikes shall be shaped and compacted with an extrusion machine or other equipment capable of shaping and compacting the material to the required cross section.

401.03.15 Pavement Reinforcing Fabric. Pavement reinforcing fabric

shall be placed on existing pavement to be surfaced or between layers of asphalt concrete when such work is shown on the plans, specified in the special provisions, or ordered by the Engineer.

The weather limitations contained in subsection 401.03.05 of these specifications shall also apply to placement of the asphalt binder and the pavement reinforcing fabric.

Before placing the pavement reinforcing fabric, a binder of paving asphalt shall be applied to the surface to receive the pavement reinforcing fabric at an approximate rate of twenty-five one-hundredths (0.25) gallon per square yard of surface covered. The exact rate will be determined by the Engineer. The binder shall be applied to a width equal to the width of the fabric mat plus three (3) inches on each side.

Before applying binder, large cracks, spalls, and chuckholes in existing pavement shall be repaired as directed by the Engineer, and such repair work will be paid for as provided in subsection 104.03, "Extra Work."

The fabric shall be stretched, aligned, and placed with no wrinkles that lap. The test for lapping shall be made by gathering together the fabric in a wrinkle. If the height of the doubled portion of extra fabric is one-half (1/2) inch or more, the fabric shall be cut to remove the wrinkle, then lapped in the direction of paving. Lap in excess of two (2) inches shall be removed.

Pavement reinforcing fabric shall not be placed in areas of conform tapers where the thickness of the overlying asphalt concrete is one (1) inch or less.

If manual laydown methods are used, the fabric shall be unrolled, stretched, aligned, and placed in increments of approximately thirty (30) feet.

Adjacent borders of the fabric shall be lapped two (2) to four (4) inches. The preceding roll shall lap two (2) to four (4) inches over the following roll in the direction of paving at ends of rolls or at any break. At fabric overlays, both the tack coat and the fabric shall overlap the previously laced fabric by the same amount.

Seating of the fabric with rolling equipment after placing will be permitted. Turning of the paving machine and other vehicles shall be gradual and kept to a minimum to avoid damage.

A small quantity of asphalt concrete, to be determined by the Engineer, may be spread over the fabric immediately in advance of placing asphalt concrete surfacing in order to prevent fabric from being picked up by construction equipment.

Public traffic shall not be allowed on the bare reinforcing fabric, except that public cross traffic shall be allowed to cross the fabric, under traffic control, after the Contractor has placed a small quantity of asphalt concrete over the fabric.

Care shall be taken to avoid tracking binder material onto the pavement reinforcing fabric or distorting the fabric during seating of the fabric with rolling equipment. If necessary, exposed binder material shall be covered lightly with sand blotter.

METHOD OF MEASUREMENT

401.04.01 Measurement. The quantity of plantmix bituminous aggregate to be measured for payment will be the number of tons conforming to all

the requirements in the completed work, and will be determined by weighing the completed mixture of aggregate, mineral filler if required, and bituminous material, and deducting from this weight the weight of the mineral filler and bituminous material.

The quantity of bituminous material to be measured for payment will be the number of tons used in the completed work and shall conform to the requirements herein.

Regardless of the type of mineral filler (lime or cement) added to the various bituminous aggregates as specified in this section of these special provisions, the lime or cement shall be classified as "mineral filler" and shall be measured for payment by the ton.

The quantity of shoulder dikes constructed of bituminous mixture, the placing of which is to be paid for as a contract item on a linear foot basis, will be determined from measurements taken along the top of the completed dikes to the nearest one (1) foot length. The quantities of bituminous mixture used to construct the dikes shall be measured as set forth above.

The quantities of bituminous mixture, the placing of which is to be paid for as a contract item on an area basis in addition to the contract prices paid for the bituminous mixture, will be determined from measurements of the bituminous mixture compacted in place.

The item of "plantmixing miscellaneous areas" shall be measured on a square yard basis in accordance with the fourth paragraph of this subsection. Areas to be included in such measurement shall be limited to those areas listed on the structure list in the plans, plus or minus changes authorized by the Engineer. Areas shall be measured one (1) time only without consideration of the number of lifts or types of bituminous mixtures involved.

In the event the proposal does not contain the bid item of "plantmixing miscellaneous areas," the cost of such work shall be considered included in the contract unit price bid for other items of work and no further compensation shall be allowed therefor.

Pavement reinforcing fabric shall be measured for payment on a square yard basis. The quantity of pavement reinforcing fabric to be measured for payment shall be that number of square yards of surface area covered. No allowance shall be made for material overlap.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities." Batch weights will not be permitted as a method of measurement unless the alternate provisions of subsection 401.03.01, "(b) Requirements for Batching Plants.", "1. Plant Scales.", are met, in which case the cumulative weight of all the acceptable batches will be used for payment.

BASIS OF PAYMENT

401.05.01 Payment. All accepted work and materials measured as provided in subsection 401.04.01, "Measurement," will be paid for as provided in the respective sections for each type specified.

Full compensation for furnishing and applying bituminous material or asphaltic emulsion as provided for in subsections 401.03.06, "Preparation of Existing Surface," and 401.03.12, "Joints," shall be considered as included

in the contract price paid for the principal items involved and no further compensation will be allowed therefor.

Where the Contractor elects to use a viscosity grade AC asphalt cement in lieu of a viscosity grade AR asphalt cement, such viscosity grade AC asphalt cement shall be paid for as viscosity grade AR asphalt cement.

The quantity of hydrated lime or Portland cement added to the aggregates and measured as provided in subsection 401.04.01, "Measurement," shall be paid for at the contract unit price bid per ton for mineral filler, which price shall be considered full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to furnish and mix the lime or cement with the aggregates as specified herein.

The contract unit price bid per square yard for pavement reinforcing fabric shall be considered full compensation for all labor, materials, tools, equipment, and incidentals necessary to furnish and install the fabric complete and in place.

The paving asphalt used to bind the pavement reinforcing fabric shall be paid for under the appropriate asphalt cement bid item.

Payment will be made under:

Pay Item	Pay Unit
Mineral Filler	Ton
Pavement Reinforcing Fabric	Square Yard

SECTION 402

PLANTMIX BITUMINOUS SURFACE

DESCRIPTION

402.01.01 General. This work shall consist of constructing one (1) or more courses of bituminous pavement on a prepared base in accordance with these specifications, and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

The requirements of Section 401, "Plantmix Bituminous Pavements—General," shall be applicable to this work, except as hereinafter specified.

MATERIALS

402.02.01 General. The materials shall conform to the requirements as specified in subsections 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements—General."

CONSTRUCTION

402.03.01 General. The construction requirements shall conform to the requirements as specified in subsections 401.03.01 through 401.03.14, inclusive, of Section 401, "Plantmix Bituminous Pavements—General," with the exception contained in the following three (3) subsections.

402.03.02 Rollers. There shall be operating with each paver, three (3) rollers meeting the requirements of (a), (b), and (c) in subsection 401.03.04, "Rollers," except as hereinafter noted.

When two (2) pavers are paving in echelon within four hundred (400) feet of each other and each paver is placing not more than one hundred fifty (150) tons of bituminous mixture per hour, then three (3) rollers meeting the requirements of (a), (b), and (c) in subsection 401.03.04, "Rollers," may be used to roll for both pavers.

402.03.03 Spreading and Finishing. Unless otherwise specified, bituminous plantmix surface shall be placed in courses not exceeding three (3) inches in compacted thickness. When more than one (1) course is placed, the courses shall be approximately equal thickness.

Bituminous plantmix surface to be placed on shoulders and other areas of the travelled way having a width of eight (8) feet or more, shall be spread as specified in subsection 401.03.10, "Spreading and Finishing." When the areas are less than eight (8) feet in width the material may be deposited and spread in one (1) or more layers by other mechanical means that will provide a uniform smoothness and texture. Placing bituminous mixture on any pavement that would be stained thereby will not be permitted.

402.03.04 Surface Tolerances. The completed surfacing shall be thoroughly compacted, smooth and free from ruts, humps, depressions, or irregularities. When a straightedge twelve (12) feet long is laid on the finished surface and paralleled with the centerline of the highway, the surface shall not vary more than two one-hundredths (0.02) foot from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than two one-hundredths (0.02) foot are present when tested with a straightedge twelve (12) feet long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

402.03.05 Recycled Plantmix Bituminous Surface. When permitted in the special provisions, the Contractor shall have the option of recycling the existing bituminous surfacing removed from this project. The material shall consist of a mixture of virgin aggregate, binder (new asphalt cement), and reclaimed asphaltic concrete conforming to the requirements of this and other appropriate sections of these specifications and the special provisions.

Should the recycle option be permitted and selected for use, existing bituminous material that is to be removed and recycled shall be stockpiled at locations selected by the Contractor, subject to approval by the Engineer. The only existing bituminous material that will be permitted to be recycled will be that material removed from within the limits of the project and said material shall be stockpiled separate and apart from bituminous materials from any sources other than the project.

The maximum percentage of reclaimed asphaltic concrete that may be incorporated into the mix and the type and grade of the asphalt cement and recycling agent (if required) shall be as specified in the special provisions. The grade of asphalt may be changed one (1) grade by the Engineer during construction at no change in unit price.

The requirements applicable to the combined virgin aggregates and the reclaimed asphaltic concrete aggregates shall be as specified in the special provisions.

Mineral filler (if required) shall be added to the combined weight of the virgin aggregate and reclaimed asphaltic concrete prior to the final mix, at the rate and in accordance with the requirements of Section 401, "Plantmix Bituminous Pavements—General."

Quality acceptance samples shall be based on the following acceptance points:

New Asphalt Cement. The binder shall be sampled in the normal manner prior to introduction into the aggregate.

Plantmix Bituminous Surface Aggregate. The gradation shall be determined from samples of the completed mixture taken from behind the paver, after extraction of the new and residual asphalt.

Representative samples submitted by the Contractor for mix design concurrence shall conform to the following:

	Min.
Virgin Aggregate	100 lbs.
Salvaged Asphaltic Concrete (processed stockpile)	100 lbs.
New Asphalt Cement	2 gals.

The reclaimed asphaltic concrete material shall be processed in a manner that will provide a uniform gradation from fine to coarse with one hundred (100) percent passing the one and one-half (1 1/2) inch sieve. This material shall not contain clay balls, foreign matter, or other deleterious material.

Prior to being introduced into the bituminous mixing plant, the reclaimed material shall be screened and all one and one-half (1 1/2) inch and larger material shall be rejected from the mixture.

The Contractor is further advised that the Engineer reserves the right to take samples of the complete mixture, at random from behind the paver, and to adjust the job-mix formula as deemed necessary without additional compensation.

Production of the reclaimed asphalt concrete shall cease immediately when tests indicate the quantity of the asphalt does not meet specified tolerances. Production of the reclaimed asphalt concrete shall not commence until the Contractor has received written approval from the Engineer.

Reclaimed material shall be introduced by means of a separate system capable of providing accurate calibration of the material feed. The system shall be equipped to indicate and control the output of the reclaimed material feed.

In all cases, the virgin aggregate and the reclaimed material shall be combined and mixed prior to the addition of asphaltic binder.

For the purpose of proportioning, reclaimed material shall be considered an aggregate, and the specifications in subsection 401.03.01 of these specifications for the positive interlock of asphalt and aggregate feed shall apply.

In a drum type plant, flames used for drying and heating shall be properly adjusted to avoid damage to the salvaged asphaltic concrete. In a batch type plant, a minimum of fifteen (15) seconds of dry mixing of salvaged and virgin aggregate shall be required. Heat of virgin aggregate shall be controlled to prevent damage to the salvaged asphaltic concrete.

Project control test for asphalt quantity shall be taken behind the paver.

The Contractor is advised that by contacting the Department's District Headquarters in the area where the project is located, he shall be allowed to obtain samples of the existing bituminous surface for further laboratory analysis. It should be understood that the Contractor will be responsible for patching all sampled areas to the Department's satisfaction at no expense to the Department.

METHOD OF MEASUREMENT

402.04.01 Measurement. Except as hereinafter provided for the recycle option, plantmix bituminous surface aggregate will be measured as specified in subsection 401.04.01, "Measurement."

Should the recycle option be permitted and selected for use, as provided in

subsection 402.03.05, "Recycled Plantmix Bituminous Surface," measurement of plantmix bituminous surface aggregate and bituminous material shall be as follows:

(a) The quantity of plantmix bituminous surface aggregate to be measured for payment will be the number of tons of combined virgin aggregate and reclaimed asphaltic concrete pavement, conforming to all the requirements in the completed work, and will be determined by weighing the completed mixture of virgin aggregate, reclaimed asphaltic concrete, mineral filler (if required), new bituminous material, residual bituminous material, and deducting from this weight the weight of mineral filler, new bituminous material, and residual bituminous material.

(b) The quantity of bituminous material to be measured for payment shall be determined as follows:

1. The amount of new bituminous material to be measured for payment shall be determined in accordance with subsection 401.04.01, "Measurement."

2. To the amount of new bituminous material added to the mixture, a predetermined percentage of recoverable old bituminous material shall be added for the purpose of payment for bituminous material in the total mix. The predetermined percentage of recoverable old bituminous material shall be set forth in the special provisions and it shall be understood and agreed by both parties to the contract that the stated percentage is firm and nonnegotiable throughout the life of the contract. The predetermined percentage shall only be applied to the reclaimed asphaltic concrete that is incorporated in the mix.

3. The percentage of new bituminous material, plus the percentage of recoverable old bituminous material, measured as provided above, shall be the quantity of bituminous material measured for payment.

Should the recycle option be permitted and selected for use, no change in normal bid items will be considered.

BASIS OF PAYMENT

402.05.01 Payment. The accepted quantity of materials measured as provided in subsection 402.04.01, "Measurement," will be paid for at the contract unit price bid per ton for plantmix bituminous surface aggregate (type), and per ton for bituminous material (asphalt cement or liquid asphalt).

The above prices shall be full compensation for furnishing all the material, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous surface as shown on the plans or established by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for plantmix bituminous surface aggregate may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Plantmix Bituminous Surface Aggregate (type)	Ton
Asphalt Cement (grade)	Ton
Liquid Asphalt (grade)	Ton
Plantmixing Miscellaneous Areas	Square Yard
Plantmix Bituminous Shoulder Dikes	Linear Foot

SECTION 403

PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

DESCRIPTION

403.01.01 General. This work shall consist of placing plantmix bituminous open-graded surface in one (1) course for surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness, and the typical cross sections shown on the plans or established by the Engineer.

When indicated on the plans, this work shall also consist of constructing scored shoulders on both shoulders of a given roadway.

The requirements of Section 401, "Plantmix Bituminous Pavements—General," shall be applicable to this work, except as hereinafter specified.

MATERIALS

403.02.01 General. The materials shall conform to the requirements as specified in subsections 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements—General."

CONSTRUCTION

403.03.01 General. The construction requirements shall conform to the requirements as specified in subsections 401.03.01 through 401.03.13, inclusive, of Section 401, "Plantmix Bituminous Pavements—General," with the exceptions contained in the following three (3) subsections.

403.03.02 Rollers. There shall be operating with each paver one (1) tandem roller weighing not less than eight (8) nor more than ten (10) tons.

In addition to the above requirements the Contractor shall supply an additional roller for the construction of scored shoulders.

The additional roller shall be the vibratory type and may be steel wheeled or a combination of steel wheel-rubber tire at the Contractor's option. However, rubber tires shall only be permitted that have a smooth or "slick" tread design. The roller shall be equipped with a water system to moisten the drums and tires sufficiently to prevent picking up bituminous material. Rollers used in the construction of scored shoulders shall weigh a minimum of six (6) tons and the vibrating mechanism shall be engaged while scoring shoulders.

The following special modifications shall be made to rollers used in constructing scored shoulders.

(a) One and one-half (1½) inch semicircular pipe or seven-eighths (⅞) inch rods shall be welded to the center of one (1) steel roller drum on each roller. Pipe or rods shall not extend beyond the edge of the drum. The pipe or rods shall be of such dimensions and spacing on the drum that the finished scored shoulder will comply with the dimensions shown on the plans.

(b) Each roller shall be equipped with an acceptable guide that extends in front of the roller and is clearly visible to the operator in order that proper alignment of the completed scored shoulder is obtained.

Rollers used to construct scored shoulders shall be positioned by using planking or other methods approved by the Engineer and extreme caution shall be taken at all times to avoid scoring at locations other than those designated on the plans.

The sequence of the work of scoring the shoulder shall be as directed by the Engineer and shall be accomplished on one (1) pass of the roller.

403.03.03 Joints. Longitudinal joints shall be constructed only on the shoulders or at the edge of travel lanes.

403.03.04 Surface Tolerances. The completed surfacing shall be thoroughly compacted, smooth and free from ruts, humps, depressions, or irregularities. When a straightedge twelve (12) feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than two one-hundredths (0.02) foot from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than two one-hundredths (0.02) foot are present when tested with a straightedge twelve (12) feet long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

METHOD OF MEASUREMENT

403.04.01 Measurement. Plantmix bituminous open-graded surface aggregate will be measured as specified in subsection 401.04.01, "Measurement."

The item of score shoulder (open-graded) shall be measured for payment by the mile. A mile shall be measured longitudinally along centerline of a given roadway and shall include scoring of shoulders on both sides of centerline.

BASIS OF PAYMENT

403.05.01 Payment. The accepted quantity of materials measured as provided in subsection 403.04.01, "Measurement," will be paid for at the contract unit price bid per ton for plantmix bituminous open-graded surface aggregate and per ton for bituminous material (asphalt cement).

The above prices shall be full compensation for furnishing all the materials, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous open-graded surface as shown on the plans or established by the Engineer.

The accepted quantity of score shoulder (open-graded), measured as provided in subsection 403.04.01, "Measurement," shall be considered full compensation for furnishing all labor, equipment, tools, supplies, and incidentals necessary to score the open-graded plantmix shoulders as shown on the plans, as specified herein, and as directed by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for plantmix bituminous open-graded surface aggregate may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Plantmix Bituminous Open-Graded Surface Aggregate	Ton
Asphalt Cement	Ton
Score Shoulder (Open-Graded)	Mile

SECTION 404

ROADMIX BITUMINOUS SURFACE

DESCRIPTION

404.01.01 General. This work shall consist of constructing one (1) or more courses of roadmix bituminous pavement on a prepared base or road surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

The mineral aggregate and bituminous material may be mixed in place in the prepared roadbed, or mixed off of the roadbed by either roadmix or plantmix methods.

This work shall also consist of furnishing, stockpiling, loading, hauling, and placing premixed bituminous paving material in accordance with these specifications, for use in patching existing surfacing, maintaining base courses, or for such other purposes set forth in the contract documents or ordered by the Engineer.

MATERIALS

404.02.01 Aggregates. Aggregates shall meet the requirements of Section 705, "Aggregates for Bituminous Courses," for the grading size and type specified. The aggregate will be accepted immediately preceding addition of bituminous material to the mix. This acceptance will be based on periodic samples of the windrow after all aggregates have been blended for each layer. When plantmix method is used, aggregates will be tested for acceptance at the bins. Attention is directed to subsection 106.04, "Samples and Tests."

When the mineral aggregate consists of material in place on the roadbed, which was not placed under the contract providing for the placing of the roadmixed surfacing, all rock or lumps of materials larger in greatest dimension than the planned surface thickness shall be removed and disposed of along the roadway and such work shall be paid for as extra work as provided in subsection 104.03, "Extra Work."

404.02.02 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one (1) grade by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials."

Bituminous material may be conditionally accepted at the source.

CONSTRUCTION

404.03.01 Motor Graders. Motor graders for spreading, shaping, and finishing mixture shall be of the self-powered type with blades not less than twelve (12) feet long and wheel bases of not less than seventeen (17) feet.

404.03.02 Distributors. The distributor shall be so designed, equipped,

maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surface up to fourteen (14) feet at readily determined and controlled rates from five one-hundredths (0.05) to two (2.0) gallons per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed two one-hundredths (0.02) gallon per square yard. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically.

404.03.03 Mixing Plants. Travelling or stationary mixing plants or other equipment of proven performance may be used by the Contractor in lieu of the specified equipment if approved. Travelling mixing plant shall have positive controls for applying asphalt.

404.03.04 Rollers. Rollers used shall conform to the requirements of subsection 401.03.04, "Rollers."

404.03.05 Weather Limitations. The mixing, spreading, and compacting of roadmix bituminous pavement shall be carried on only when the surface on which the material is to be placed is dry and when the atmospheric temperature is above fifty (50) degrees Fahrenheit, and has not been below forty (40) degrees Fahrenheit during the preceding twenty-four (24) hours.

404.03.06 Preparation of Existing Surface. Before spreading materials for roadmixing, the surface of the base or road surface on which the roadmix is to be placed shall be conditioned as specified in subsection 401.03.06, "Preparation of Existing Surface."

After a prime coat is applied, it shall be left undisturbed not less than twenty-four (24) hours. The Contractor shall maintain the primed surface until the roadmix material has been placed. This maintenance shall include the spreading of sand or other material, if necessary to prevent adherence of the prime coat to the tires of vehicles using the primed surface, and patching any breaks in the primed surface with additional bituminous material. Any area of primed surface that has become damaged shall be repaired before the roadmix material is placed.

404.03.07 Placing Aggregates. Mineral aggregate shall be deposited upon the prepared subgrade, or mixing area, by the use of spreader boxes, or from the vehicles equipped or supplemented with suitable spreading devices.

The mineral aggregate shall contain sufficient material to construct the roadmix surfacing as planned, including sufficient material for surfacing special features off the travelled way. The aggregate shall not be mixed with earth or other deleterious matter.

If the moisture content of the aggregate is more than two (2) percent by weight of the dry weight of the aggregate, except when the bituminous material is emulsified asphalt, the aggregate shall be turned by blades or disc harrows or otherwise aerated until the moisture content is reduced to two (2)

percent or less. The aggregate shall then be spread smoothly and uniformly over half the road or other convenient width of the surface ready for the application of bituminous material, except that when a travelling mixing plant is used the aggregate shall be formed into a uniform cross section.

In lieu of aerating and drying the aggregate, the Contractor may use an approved additive. The additive shall permit suitable coating of the wet aggregate and shall prevent the bituminous coating from stripping in the presence of water.

404.03.08 Application of Bituminous Material. The bituminous material shall be uniformly distributed in successive application, in such amounts and at such intervals as directed. The temperature of the bituminous material shall conform to the applicable requirements of subsection 406.03.04, "Application of Bituminous Material." The mixing equipment shall follow immediately behind the distributor after each application of bituminous material to partially mix the aggregate and the bituminous material. No more bituminous material shall be applied per day than can be mixed with the aggregate on the same day it is applied.

Liquid asphalt shall not be applied when the moisture content of the aggregate exceeds two (2) percent by weight of the dry aggregate as determined by Test Method No. Nev. T112C.

404.03.09 Mixing. The materials may be mixed upon the roadbed, or upon some other approved area off the roadbed, by roadmixing methods, or the material may be mixed at a central mixing plant by plantmixing methods as specified below, whichever the Contractor elects.

(a) Roadmixing Methods. Prior to applying the bituminous material the prepared aggregate shall be spread smoothly and uniformly over one-half (1/2) the mixing area or some other convenient width. The first application of bituminous material shall then be applied and partially mixed with the aggregate. The remaining applications of bituminous material with a partial mixing after each applications shall follow in like manner. After the last application of bituminous material and partial mixing, the entire mass of bituminous material and aggregate shall be windrowed on the mixing surface and then thoroughly mixed and combined by the mixing units specified, by blading the mix from side to side of the mixing surface, or by a manipulation producing equivalent results, until all particles are coated with bituminous material and the whole mass has uniform color and the mixture is free from spots containing an excess or deficiency of bituminous material, balls, or uncoated particles. During the mixing operations, care shall be taken to avoid cutting into the underlying course or contaminating the mixture with earth or other extraneous matter. When so directed by the Engineer, the mixing process shall be confined to part of the width or area of the roadbed so as to allow a convenient passage for traffic.

Prior to spreading and compacting, should the mixture show an excess or deficiency of bituminous material, or an uneven distribution thereof, the condition shall be corrected by adding mineral aggregate or bituminous material, as the case may be, and then remixing to produce a satisfactory

mixture. If necessary, all compressed masses of mixed materials shall be broken up.

When the mineral aggregate consists of the existing material on the roadbed and an allowance for additional mineral aggregate has not been provided for on the plans, additional mineral aggregate may be obtained by scarifying material from the roadbed as directed by the Engineer or, in lieu thereof, the Contractor may import suitable material. No additional compensation will be allowed for conforming to the above requirements, except that additional materials imported and added to that in place will be paid for as extra work as provided in subsection 104.03, "Extra Work."

The amount of material mixed in any one (1) day shall not be more than can be spread and compacted on the following day, provided, however, that when directed by the Engineer, mixed material may remain in the windrow for a longer period.

In lieu of mixing the material as above specified, a roadmixing machine or any equipment other than that required above may be employed which will produce the completed mixture equal to that which would be produced by the means above specified. The Department reserves the right to order the use of any equipment discontinued which, in the opinion of the Engineer, fails to produce a satisfactory mixture.

The roadmixing machine shall be of the pugmill or auger type which picks up the loose material from the mixing area or it may be of the type which cuts a true plane in material at a specified depth, leaving no loose material in either case. Either type shall introduce the bituminous material through a metering device at the time of mixing. The machine shall be equipped to provide for a positive control of the amount of bituminous material introduced into the mix, which can be readily adjusted to the changes required.

The rate of movement of the roadmixing machine, the amount of the material mixed and the amount of mixing shall be so regulated that a mix satisfactory to the engineer will result. The materials shall be mixed until a uniform mixture of unchanging appearance is obtained and all particles of aggregate are thoroughly coated with bituminous materials. Before mixing, the loose materials shall be placed in windrows or in a blanket of uniform cross section and of such size that all the material in the windrow or blanket can be passed through the mixing machine at each mixing operation.

Materials mixed off the roadbed shall be uniform in character and equal in all respects to that which would be produced by mixing on the roadbed as above specified.

(b) Plantmixing Method. Should the Contractor elect to mix the materials at a central mixing plant by the plantmix method, the aggregate shall be mixed with the liquid asphalt in accordance with the applicable requirements of Section 401 of the standard specifications and these special provisions except that when the moisture content of the aggregate is two (2) percent or less by weight of the dry aggregate as determined by Test Method No. Nev. T112B, mixing of the materials without passing the aggregate through a dryer will be permitted.

Unless otherwise specified in the special provisions, separation of the mineral aggregate into required sizes and storing in separate bins will not be required.

404.03.10 Spreading, Compacting, and Finishing. Before the finished mixture is spread for compaction, a triangular cut shall be made with a motor grader at each edge of the base course to provide for a thickened edge of bituminous mixture. The cut shall be approximately two (2) inches deep at the outer edge and slope to zero (0), two (2) feet in toward the center. In making a cut the excavated material shall be thrown to the edge of the roadbed in a small windrow against which the mixture shall then be spread.

After roadmixing operations have been completed and the mixture has been approved by the Engineer, the mixture shall be uniformly spread over the area to be surfaced to the proper width and to such depth as will compact to the required thickness. The mixture shall be spread by means of a motor grader meeting the requirements of subsection 404.03.01, "Motor Graders."

Segregation of coarse or fine particles shall be avoided and the mixture shall be free from lumps or pockets of coarse and fine material after spreading.

After the mixture has been spread as above specified, approximately the top one-half (1/2) of the material shall be removed by motor graders and placed into a windrow on one (1) side. The windrow shall be so placed that earth or other extraneous materials will not become intermixed with the windrowed material, shall then be respread over the entire surface by alternating the windrow from one (1) side of the roadbed to the other and to the center and gradually decreasing the amount of material moved, until the entire surface has uniform texture and is smooth and true to cross section and grade and is uniformly compacted. During blading and rolling, all lumps and loose stones shall be moved to the outside of the surface area and disposed of.

All rolling, except the final finish rolling, shall be done with pneumatic-tired rollers. The finish rolling shall be done with steel-tired tandem or three (3) wheeled rollers commencing at the lower edge, progressing toward the highest portion. Under no circumstances shall the highest portion be rolled first.

404.03.11 Miscellaneous Areas. Surfacing of road approaches and connections, street intersection areas, frontage roads, median strip areas, island areas, sidewalks, dikes, gutters, gutter flares, ditches, overside drains, spillways, aprons at the ends of the drainage structures, and other designated areas outside the travelled way shall conform to the provisions specified in these specifications.

The combined aggregate grading for bituminous mixtures placed on miscellaneous areas shall conform to that specified for the bituminous mixture placed on the travelled way. The amount of bituminous material used in the bituminous mixture placed in dikes, gutters, gutter flares, overside drains, spillways, aprons at the ends of drainage structures, and other designated areas outside the travelled way shall be increased not less than one (1) percent by weight of the aggregate over the amount of bituminous material used in the bituminous mixture placed on the travelled way.

404.03.12 Surface Tolerances. The surface will be tested by the Engineer using a twelve (12) foot straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two (2) contacts with the surface shall at no point exceed three one-hundredths (0.03)

foot. All humps or depressions exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material as specified.

404.03.13 Premixed Bituminous Paving Material. The stockpile or mixing table area shall be cleared of all brush, rubbish, and deleterious matter.

The constituents of the premixed material shall be combined by any of the methods permitted in these specifications and in such proportions as to produce a mixture conforming to the following composition:

	Percent by Weight
Total Mineral Aggregate	93–96
Asphaltic Binder	4–7

The material shall be transported, placed and compacted in a manner that will provide the public with a paved, smooth, and stable riding surface as approved by the Engineer.

METHOD OF MEASUREMENT

404.04.01 Measurement. The quantity of roadmix bituminous surface aggregate to be measured for payment will be the number of tons or cubic yards as indicated in the proposal, conforming to all the requirements in the completed work. When the mixture is mixed at a central mixing plant by the plantmix method, the number of tons will be determined by weighing the completed mixture of aggregate and bituminous material and deducting from this weight the weight of the bituminous material.

Mineral aggregate consisting of material in place on the roadbed will not be measured and paid for, except for the removal of rocks and lumps as provided in subsection 404.02.01, "Aggregates," of this section. All other work involved in scarifying and preparing the material as herein specified shall be considered as included in the contract unit price paid for mixing and roadmix surfacing.

Mixing and compacting shall be measured in miles along the centerline of the roadway and no extra allowance will be made for mixing widened sections and shoulder dikes, unless otherwise provided in the special provisions.

The quantity of shoulder dikes constructed of bituminous mixture, the placing of which is to be paid for as a contract item on a linear foot basis, will be determined from measurements taken along the top of the completed dikes to the nearest one (1) foot length. The quantities of bituminous mixture used to construct the dikes shall be measured as set forth above.

The quantities of bituminous mixture, the placing of which is to be paid for as a contract item on an area basis in addition to the contract prices paid for the bituminous mixture, will be determined from measurements of the bituminous mixture compacted in place.

The quantity of premixed bituminous paving material to be measured for payment shall be the number of tons, square yards, or cubic yards, as indicated in the proposal, of acceptable aggregate conforming to all the

requirements in the completed stockpile, less the weight of liquid asphalt incorporated in the mix.

The quantity of haul and place premixed bituminous paving material to be measured for payment shall be the number of tons, square yards, or cubic yards, as indicated in the proposal, of the aggregate and asphalt mixture acceptably placed and compacted on the roadbed in the completed work.

When it is indicated in the proposal that premixed bituminous paving material and/or haul and place premixed bituminous paving material is to be measured for payment on a force account basis, measurement shall be made in accordance with subsection 109.03, "Extra and Force Account Work."

Except when the unit of measurement in the proposal for premixed bituminous paving material is force account, bituminous material shall be measured for payment by the ton in accordance with Section 401, "Plantmix Bituminous Pavements—General."

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities." Batch weights will not be permitted as a method of measurement unless the alternate provisions of subsection 401.03.01, "(b) Requirements for Batching Plants.", "1. Plant Scales.", are met, in which case the cumulative weight of all the acceptable batches will be used for payment.

Tonnage shall conform reasonably close to that shown on the plans, unless otherwise directed. Due to possible variations in the specific gravity and voids of the aggregates, the thickness may vary from that shown on the plans.

BASIS OF PAYMENT

404.05.01 Payment. The accepted quantity of materials measured as provided in subsection 404.04.01, "Measurement," will be paid for at the contract unit price bid per ton or cubic yard for roadmix bituminous surface aggregate, per ton for bituminous material (liquid asphalt), and per mile for mixing the roadmix bituminous pavement.

The above prices shall be full compensation for furnishing all the material, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing roadmix bituminous surface, as shown on the plans or established by the Engineer.

Full compensation for furnishing and applying bituminous material or asphaltic emulsion as provided for in subsection 404.03.06, "Preparation of Existing Surface," shall be considered as included in the contract price paid for the principal items involved and no further compensation will be allowed therefor.

The accepted quantity of premixed bituminous paving material and haul and place premixed bituminous paving material, measured as provided in subsection 404.04.01, "Measurement," will be paid for by the unit indicated in the proposal.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for roadmix bituminous surface aggregate may be made in accordance with subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Roadmix Bituminous Surface Aggregate	Ton or Cubic Yard
Liquid Asphalt (grade)	Ton
Mixing Roadmix Bituminous Surface (width)	Mile
Roadmixing Miscellaneous Areas (type)	Square Yard
Roadmix Bituminous Shoulder Dikes	Linear Foot
Premixed Bituminous Paving Material	Ton, Square Yard, Cubic Yard, Force Account
Haul and Place Premixed Bituminous Paving Material	Ton, Square Yard, Cubic Yard, Force Account

SECTION 405

TACK COAT

DESCRIPTION

405.01.01 General. This work shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

405.02.01 Bituminous Material. Bituminous material for the tack coat shall be "Emulsified Asphalt, Type SS-1h (Diluted);" however, the Contractor may, at his option, substitute "Emulsified Asphalt, Type SS-1 (Diluted)" for "Emulsified Asphalt, Type SS-1h (Diluted)." Regardless of the option chosen, bituminous material for the tack coat shall be measured and paid for under the bid item and at the contract unit price bid per ton for "Emulsified Asphalt, Type SS-1h (Diluted)" and no further compensation shall be allowed therefor.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

Asphaltic emulsion used as a tack coat between the courses of plantmix surface or over an existing surface shall be of the type and grade specified and prepared for application as follows:

The emulsion shall be cut back by water. Water shall be added in the quantity of forty (40) percent of the emulsion by weight. To accomplish this mixing, the distributor shall be partly filled with water, and the correct proportion of emulsified asphalt shall then be added, and the remaining water to be added shall be sprayed into the tank under pressure and then thoroughly circulated within the distributor.

CONSTRUCTION

405.03.01 Equipment. The Contractor shall provide equipment for heating and applying the bituminous material. This equipment shall meet the requirements of subsection 404.03.02, "Distributors."

405.03.02 Weather Limitations. Application of bituminous material will not be permitted when the surface to be treated is damp or wet or when weather conditions are unsuitable or when the atmospheric temperature or aggregate temperature is below forty (40) degrees Fahrenheit.

405.03.03 Preparation of Surface. The existing surface shall be patched and cleaned and be free of irregularities to provide a reasonably smooth and uniform surface to receive the treatment. The edges of existing

pavements, which are to be adjacent to new pavement, shall be cleaned to permit the adhesion of bituminous materials.

When a tack coat is required on the surface of a new course of pavement, the surface shall be cleaned to the satisfaction of the Engineer prior to applying the tack coat. Attention is directed to subsections 104.04, "Maintenance of Traffic," and 105.14, "Maintenance During Construction."

405.03.04 Application of Bituminous Materials. The bituminous material shall be uniformly applied at the rate called for on the plans or ordered by the Engineer. When asphaltic emulsion or liquid asphalt is used, the temperature at the time of application shall conform to the applicable requirements in Table I of subsection 406.03.04.

The tack coat shall be applied in such manner as to offer the least inconvenience to traffic and to permit one (1) way traffic without pickup or tracking of the bituminous material. Tack coat shall be applied only so far in advance that it will be covered during the following thirty-six (36) hours.

METHOD OF MEASUREMENT

405.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of tons conforming to all the requirements in the completed work.

Bituminous material diluted as prescribed shall be measured in tons of the diluted mixture acceptably applied to the surface.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

405.05.01 Payment. The accepted quantity of bituminous material measured as provided in subsection 405.04.01, "Measurement," will be paid for at the contract unit price bid per ton.

The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, and incidentals necessary for doing all the work involved in placing tack coat, as shown on the plans or established by the Engineer, all in accordance with subsection 109.02, "Scope of Payment."

The cost of cleaning and preparing existing and new pavement surfaces to receive a tack coat as provided in this subsection and as directed by the Engineer, shall not be paid for directly but the cost thereof shall be considered included in the contract unit price paid for other items of work and no further compensation shall be allowed therefor.

The Department reserves the right to increase or to omit all or any part of the estimated amount of bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton

SECTION 406

PRIME COAT

DESCRIPTION

406.01.01 General. This work shall consist of preparing and treating an existing surface with bituminous material, and blotter material, if required, in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

406.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one (1) grade by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

406.02.02 Sand Blotter. Sand blotter shall meet the requirements of subsection 705.03.06, "Sand Blotter." The material may be accepted in stockpile at the source.

CONSTRUCTION

406.03.01 Equipment. The Contractor shall provide equipment for heating and applying the bituminous material and for applying blotter material. The equipment shall meet the requirements of subsection 404.03.02, "Distributors."

406.03.02 Weather Limitations. Bituminous material shall not be applied on a wet surface, when the atmospheric temperature is below fifty (50) degrees Fahrenheit, or when weather conditions, in the opinion of the Engineer, would prevent the proper construction of the prime coat.

406.03.03 Preparation of Surface. The surface upon which the bituminous prime coat is to be placed shall conform to the established lines and grades, shall be reasonably smooth and uniform and shall be compacted to the required density. If the required density deteriorates from the time the gravel course was compacted originally and the time the prime coat is placed, for any reason whatsoever, then the surface shall be recompacted to the required density at the expense of the Contractor. When required by the Engineer, an application of water shall be applied immediately before the bituminous application.

406.03.04 Application of Bituminous Material. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. When traffic is main-

tained, not more than one-half (1/2) of the width of the section shall be treated in one (1) application. Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified amount. Excess bituminous material shall be squeegeed from the surface. Skipped areas or deficiencies shall be corrected.

When traffic is maintained, one (1) way traffic shall be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be transferred to the treated portion and the remaining width of the section shall be primed.

The bituminous material shall be uniformly applied at the rate called for on the plans or ordered by the Engineer.

The temperature requirements pertaining to the application of the liquid asphalts and asphaltic emulsions shall conform to the requirements of the following Table I:

TABLE I

Spraying and Mixing Temperatures of Liquid Asphalts and Asphaltic Emulsions

Grade and Type RC, MC, and SC	Distributor Spraying Temp. °F.		*Pugmill Mixing Temp. °F. of Liquid Asphalt MC and SC	
	Minimum	Maximum	Minimum	Maximum
70	120	180	95	140
250	165	220	135	175
800	200	255	165	205
3,000	235	290	200	240

*The maximum spraying temperature may be used if the aggregate is not heated.

Grade of Asphalt Emulsion	Distributor Spraying Temp. °F.		*Pugmill Mixing Temp. °F. of Emulsion and Aggregates	
	Minimum	Maximum	Minimum	Maximum
RS-1, CRS-1	75	130	(Not used for mixing)	
RS-2, CRS-2	110	160	(Not used for mixing)	
SS-1, CSS-1	75	130	50	130
SS-1h, CSS-1h	75	130	50	130
CMS-2S	100	160	60	140

*The maximum spraying temperature may be used if the aggregate is not heated.

406.03.05 Application of Blotter Material. If, after the application of the prime coat, the bituminous material fails to penetrate within three (3) to six (6) days and the roadway must be used by traffic, blotter material shall be spread in the amounts required to absorb any excess bituminous material. When necessary for traffic, blotter material may be spread prior to three (3) days' penetrating time.

METHOD OF MEASUREMENT

406.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of tons conforming to all the requirements in the completed work. The quantity of blotter sand measured for payment will be the number of tons or cubic yards conforming to all the requirements in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

406.05.01 Payment. The accepted quantity of materials measured as provided in subsection 406.04.01, "Measurement," will be paid for at the contract unit price bid per ton for bituminous material and per ton or cubic yard for blotter sand.

When sand blotter is not included in the proposal and it is needed to protect the work or public traffic, it shall be furnished and spread as herein described, and payment therefor will be in accordance with subsection 104.03, "Extra Work."

The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, and incidentals necessary for doing all the work involved in placing prime coat and sand blotter, as shown on the plans or established by the Engineer.

The Department reserves the right to increase or to omit all or any part of the estimated amount of blotter material or bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton
Sand Blotter	Ton or Cubic Yard

SECTION 407

SEAL COAT

DESCRIPTION

407.01.01 General. This work shall consist of an application of bituminous material on a compacted and bonded bituminous surface, and blotter material, if required, in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

407.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one (1) grade by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

407.02.02 Sand Blotter. Sand blotter shall meet the requirements of subsection 705.03.06, "Sand Blotter." The material may be accepted in stockpile at the source.

CONSTRUCTION

407.03.01 Equipment. The Contractor shall provide equipment for heating and applying the bituminous material and for applying blotter material. The equipment shall meet the requirements of subsection 404.03.02, "Distributors."

407.03.02 Weather Limitations. Bituminous material shall not be applied on a wet surface, when the temperature is below fifty (50) degrees Fahrenheit, or when weather conditions, in the opinion of the Engineer, would prevent the proper construction of the seal coat.

407.03.03 Preparation of Surface. Immediately before applying the bituminous material the surface to be sealed shall be thoroughly cleaned of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary. The process of cleaning shall continue until dirt and loose material is removed from the entire width of the surfacing.

407.03.04 Application of Bituminous Material. Bituminous material shall not be spread later in the day than will permit the stopping of traffic control prior to darkness. Bituminous material shall be applied to only one (1) designated traffic lane at a time and the entire width of the lane shall be covered in one (1) operation.

The bituminous material shall be uniformly applied at the rate called for on

the plans or ordered by the Engineer. The temperature of the bituminous material shall conform to the applicable requirements of subsection 406.03.04, "Application of Bituminous Material."

The seal coat shall be applied in such manner as to offer the least inconvenience to traffic and to permit one (1) way traffic without pickup or tracking of the bituminous material.

When a surface treatment is to be applied to the central portion of the pavement, the seal coat shall be applied to the shoulder at least four (4) days in advance of the application of the adjacent surface treatment requiring screenings, and the seal coats shall be applied in such a manner that the joint between the two (2) types will present a neat and uniform appearance true to the line shown on the typical cross section and as established by the Engineer.

407.03.05 Application of Blotter Material. The applicable requirements of Section 406, "Prime Coat," shall apply to this Section 407, "Seal Coat," when sand blotter is required.

METHOD OF MEASUREMENT

407.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of tons conforming to all the requirements in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

407.05.01 Payment. The accepted quantity of materials measured as provided in subsection 407.04.01, "Measurements," will be paid for at the contract unit price bid per ton for bituminous material.

The above price shall be full compensation for furnishing the material, mixing, loading, hauling, placing, and incidentals necessary for doing all the work involved in placing seal coat as shown on the plans or established by the Engineer.

The Department reserves the right to increase or to omit all or any part of the estimated amount of bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

Sand blotter will be paid for in accordance with Section 406, "Prime Coat."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton

SECTION 408

SURFACE TREATMENT

DESCRIPTION

408.01.01 General. This work shall consist of an application of bituminous material and cover of screenings applied on a previously compacted and bonded bituminous surface, all in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

408.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one (1) grade by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

408.02.02 Screenings. Screenings shall meet the requirements of subsection 705.03.05, "Screenings," for the size specified. Attention is directed to subsection 106.04, "Samples and Tests."

CONSTRUCTION

408.03.01 Distributors. The distributor shall meet the requirements of subsection 404.03.02, "Distributors."

408.03.02 Aggregate Spreader. The aggregate spreader shall be self-propelled and supported by at least four (4) wheels equipped with pneumatic tires on two (2) axles. The aggregate spreader shall be equipped with positive control so that the required amount of material will be deposited uniformly over the full width of the bituminous material.

408.03.03 Rollers. There shall be operating with each aggregate spreader, one (1) pneumatic-tired roller and one (1) steel-wheel roller. The pneumatic-tired roller shall meet the requirements of subsection 401.03.04(b), "Rollers." The steel-wheel roller shall meet the requirements of the same subsection, (a) or (c).

408.03.04 Weather Limitations. Bituminous material shall not be spread when weather conditions are unsuitable, when the atmospheric temperature is below sixty-five (65) degrees Fahrenheit, or the pavement temperature is below eighty (80) degrees Fahrenheit.

408.03.05 Maintaining Traffic. Where public traffic is being routed over a surface upon which a surface treatment is to be applied, the surface

treatment shall not be applied to more than one-half (1/2) the width of the travelled way at a time, and the remaining half width shall be kept free of obstructions and open for use by public traffic at all times until the surface treatment first applied is ready for use by traffic.

Traffic will not be allowed on the newly placed bituminous material and screenings until, in the opinion of the Engineer, the screenings and bituminous material have sufficiently set and bonded to prevent displacement by such traffic.

When the newly completed surface treatment is open to traffic, the traffic shall be controlled by use of flagmen and a pilot car for a period of six (6) hours or for such time as deemed necessary by the Engineer as follows:

(a) A flagman shall be stationed at the beginning of each newly completed section open to traffic, to stop oncoming traffic preparatory to piloting operations and shall be kept on duty during the entire control period.

(b) Traffic control as described above shall be moved ahead progressively as the newly completed surface is open to traffic.

408.03.06 Preparation of Surface. Immediately before applying the bituminous material, the surface to be treated shall be thoroughly cleaned of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary. The process of cleaning shall continue until the surfacing is exposed and all dirt and loose material is removed from the entire width of surfacing.

408.03.07 Application of Bituminous Material. Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated. The temperature of the bituminous material shall conform to the applicable requirements of subsection 406.03.04, "Application of Bituminous Material." The quantity of bituminous material to be used per square yard shall be as directed if the texture of the surface is such that bituminous material penetrates too rapidly, a preliminary application of from five one-hundredths (0.05) to one-tenth (0.1) gallon per square yard of surface may be required. A strip of building paper at least three (3) feet in width and with a length equal to that of the spray bar of the distributor plus one (1) foot, shall be used at the beginning of each spread. If the cutoff is not positive, the use of paper may be required at the end of each spread. The paper shall be removed and disposed of in a satisfactory manner. The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Any skipped areas or deficiencies shall be corrected. Junctions of spreads shall be carefully made to assure a smooth riding surface.

The length of spread of bituminous material shall not be in excess of that which trucks loaded with screenings can immediately cover.

The spread of bituminous material shall not be more than six (6) inches wider than the width covered by the screenings from the spreading device. Under no circumstances shall operations proceed in such manner that bituminous material will be allowed to chill, set up, dry, or otherwise impair retention of the screenings.

The distributor, when not spreading, shall be parked so that the spray bar or

mechanism will not drip bituminous materials on the surface of the travelled way.

408.03.08 Application of Screenings. Immediately following the application of the bituminous material, screenings shall be spread at the required rate per square yard.

In order to avoid building a longitudinal joint, when spreading screenings on the first width of bituminous material, no screening shall be applied within six (6) inches of the edge adjacent to the next application of bituminous material.

Bituminous material and screenings shall not be spread over a greater distance than can be rolled and finished within one (1) day's operation.

In order to eliminate dust film, screenings shall be moistened with water before being applied. In spreading the screenings, the equipment used shall be so operated that the fresh bituminous material will be covered before equipment wheels come upon it.

Asphaltic emulsion applied to the road surface shall be covered with screenings before setting or breaking occurs.

After the screenings have been spread upon the bituminous material, any piles, ridges, or uneven distribution shall be carefully removed with flat bottom shovels or other approved methods to insure against permanent ridges or bumps in the completed surface. Additional screenings shall be spread by hand in whatever quantities required to prevent picking up by the rollers or traffic.

After the application of the screenings the surface where specified shall be lightly broomed or otherwise maintained as directed for a period of four (4) days or as directed. Maintenance of the surface shall include the distribution of screenings over the surface to absorb any free bituminous material and cover any area deficient in screenings. The maintenance shall be conducted so as not to displace imbedded material. Excess material shall be swept at the time determined by the Engineer.

408.03.09 Rolling. Rolling shall follow immediately behind spreading screenings to properly embed the screenings in the soft bituminous material and rolling shall commence at the outer edges and proceed toward the inner edge of each spread of bituminous material and screenings, and shall be continued until the screenings are thoroughly set.

The sequence of rollers and roller patterns will be established by the Engineer.

METHOD OF MEASUREMENT

408.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of tons conforming to all the requirements in the completed work. The quantity of screenings measured for payment will be the number of tons or cubic yards conforming to all the requirements in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

408.05.01 Payment. The accepted quantity of materials measured as provided in subsection 408.04.01, "Measurement," will be paid for at the contract unit price bid per ton for bituminous material and per ton or cubic yard for screenings.

The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, rolling, sweeping, and incidentals necessary for doing all the work involved in placing bituminous material and screenings, as shown on the plans or established by the Engineer.

The Department reserves the right to increase or to omit all or any part of the estimated amount of screening material or bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

Flagmen and pilot cars will be paid for in accordance with Section 624, "Accommodations for Public Traffic."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton
Screenings	Ton or Cubic Yard

SECTION 409

PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

409.01.01 General. This work shall consist of a pavement composed of Portland cement concrete, with or without reinforcement as specified, constructed on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross section shown on the plans or established by the Engineer.

At the option of the Contractor, concrete pavement may be constructed with equipment utilizing stationary side forms or by the use of slip-form paving equipment.

MATERIALS

409.02.01 General. Materials shall conform to the requirements of the following sections and subsections:

Fine Aggregate	Subsection 706.03.03
Coarse Aggregate	Subsection 706.03.01
Portland Cement	Section 701
Water	Section 722
Air-Entraining Admixtures	Section 702
Joint Filler	Subsection 707.03.01
Curing Materials	Section 702
Reinforcement	Section 713

Portland cement shall be Type II "low alkali" or Type IP "blended" cement, except as otherwise provided in subsection 409.03.13 of these specifications.

An inadequate water supply shall be concluded sufficient cause for delaying or stopping mixing operations. In case of a deficiency of water, the requirements for subgrade and curing concrete previously placed shall have priority over mixing.

409.02.02 Gradation Requirements. Gradation requirements shall conform to the requirements as specified in subsection 501.02.02, "Gradation Requirements."

409.02.03 Concrete Properties and Tests. Portland cement concrete pavement shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Flexural Strength of Concrete	Nev. T442	Subsection 409.03.13, "Protection of Pavement." See "Note (D)."
Length of Drilled Cores	Nev. T452	Subsection 409.04.02, "Pavement Thickness."
Proportions of Coarse Aggregate in Fresh Concrete	Nev. T449*	Compliance with uniformity specified in test method.
Slump	Nev. T439 or Nev. T438	Table I. See "Note (A)."

Test	Test Designation	Requirements
Evaluation of Profiles	Nev. T446	Subsection 409.03.11, "Riding Tolerances."
12 foot Straightedge Tolerances	Nev. T380	0.01 ft. max. longitudinal—0.02 ft. max. transverse.
Method of Test for Specific Gravity and Absorption of Coarse Aggregate	Nev. T492	Min. saturated surface dry condition.
Method of Test for Specific Gravity and Absorption of Fine Aggregate	Nev T493	Min. saturated surface dry condition.
Entrained Air Content	Nev. T431 or Nev. T432	Table I. See "Note (B)."
Compressive Strength of Concrete	Nev. T475	Subsection 409.03.01. See "Note (C)."
Unit Wt., Volume and Cement Factor of Concrete	Nev. T435	Table I and subsection 409.03.01, "Classification and Proportions."

*Referee Test Method.

All concrete shall be sampled in accordance with Test Method No. Nev. T425, except that the sample shall be taken from the truck with a square mouth shovel at the batch plant platform. The Engineer shall test the concrete mix and shall inspect the batching procedures to ascertain compliance with the mix design. The Department will furnish the molds and machines for testing and the Contractor, at his expense, shall furnish the material and internal vibrators for making the tests.

Note (A): Slump. Each truckload of concrete shall be tested at the batch plant for ball penetration (Kelly Ball Test) in accordance with Test Method No. Nev. T439. Only one Kelly Ball Test per truck need be performed. The ball penetration test shall not be used for acceptance or rejection but only to indicate the consistency of the concrete. If the consistency appears to be out of specification, a slump test shall be made immediately. If the first slump test does not meet the specification, a second test shall be made immediately on the same load. The concrete shall be accepted if the second test meets the specification or rejected and wasted if the second test does not meet the specification. Slump tests shall be made in accordance with Test Method No. Nev. T438.

Note (B): Air Content. Entrained air content tests shall be made at the batch plant platform with concrete sampled from the trucks. In addition to the minimum testing frequency, air tests shall be made on the first three (3) truckloads of concrete produced each morning and the first three (3) truckloads produced after shutdown of more than one (1) hour. The batching operation shall be slowed down to allow completion of each air test before the next batch is made so test results can be communicated to the batch plant operator and necessary correction can be made. Additional air tests may be taken at the discretion of the Engineer. If an air test does not meet the specification, a second air test from a new sample shall be made immediately on the same load. The concrete shall be accepted if the second air test meets the specification or rejected and wasted if the second air test does not meet the specification. Air tests shall be made in accordance with Test Methods No. Nev. T431 or T432, except that one (1) method will be selected and used throughout the contract.

Note (C): Compressive Strength. Concrete cylinders will be molded and stored on the platform at the batch plant. Making and curing concrete cylinders shall be in accordance with Test Method No. Nev. T428. Compressive strength of concrete shall be determined from "strength tests" in which the average strength of three (3) standard cylinders shall constitute one (1) strength test. Compressive strength tests shall be made in accordance with Test Method No. Nev. T475. One (1) strength test shall be made for each seven hundred fifty (750) cubic yards or one thousand five hundred (1,500) tons or portion thereof which will constitute a test lot. The location on the grade where the concrete sampled for compressive strength is placed shall be recorded.

Note (D): Flexural Strength. Flexural beams will be cast and stored on the platform at the batch plant. Beams shall be prepared and tested in accordance with Test Method No. Nev. T442, with the exception that initial curing will be in the insulated shed on the platform.

409.02.04 Admixtures. Use of admixtures in Portland cement concrete pavement shall conform to the requirements of subsection 501.02.03 of these specifications.

CONSTRUCTION

409.03.01 Classification and Proportions. The Contractor shall notify the Engineer not less than thirty-two (32) calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes.

When requested by the Contractor and allowed in writing by the Engineer, samples will not be required from aggregate sources previously tested within the past one (1) year.

Samples will not exceed five hundred (500) pounds for each separate grading. The Contractor shall furnish a written statement giving the cement factor in sacks per cubic yard, the proportions of cement, water, and each size of aggregate by weight, in S.S.D. condition, and the percentage of air in the concrete proposed for use in the work. If the Contractor proposes to use an admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement. The Engineer, after making such tests as he deems advisable, will either accept the proposed materials and proportions or suggest modifications needed for acceptance. After acceptance by the Engineer of batch proportions and materials, they shall not be altered during the course of the work except as found necessary to maintain yield, cement factor, and unit weight within specification requirements.

Changes in batch proportions and materials as permitted in this subsection shall not be allowed without written prior approval of the Engineer.

Portland cement concrete shall be proportioned, using the aggregates tested, such that the requirements in this subsection will be satisfied without falling below the minimum or exceeding the maximum values given.

The cement factor of any individual batch placed in the work shall not be more than fifteen one-hundredths (0.15) sack per cubic yard less, nor more

than twenty-five one-hundredths (0.25) sack per cubic yard greater than the designated factor (sacks of cement per cubic yard). Aggregates shall be batched and reported to the Engineer. The weights used may be varied as necessary to comply with the above tolerances in cement factor.

Coarse and fine aggregate in each batch of concrete shall be combined in proportions that will produce a mixture within the grading limits for combined aggregates specified as follows:

Grading Limits of Combined Aggregates

Sieve Sizes	Percentage Passing
2″	100
1 1/2″	90–100
1″	50–86
3/4″	45–75
3/8″	38–55
No. 4	30–45
No. 8	23–38
No. 16	15–33
No. 30	8–22
No. 50	4–13
No. 100	1-5
No. 200	0–3

TABLE I

Class of Concrete	Sacks Cem. Per Cu. Yd., Min.-Max.	Coarse Agg. Size No.	Max. Water, Gal. Per Sack Cem.*	Slump Range, Inches	Air Range, Percent	Unit Weight Variation
P.C.A.A.	6.0–7.5	467	5.5	0–3.0	5±1	±3 lbs.

*Based on aggregate in a saturated surface dry condition.

The nominal slump in inches shall be three (3) inches—the maximum slump shall be three and five-tenths (3.5) inches. When the slump of concrete is found to exceed the nominal slump, the mixture shall be adjusted as directed by the Engineer to reduce slump to a value within the nominal range. Four (4) slump tests will be considered sufficient to determine nominal slump. The difference in slump, determined by comparing slump tests on two (2) samples of mixed concrete for each individual batch tested, shall not exceed one (1) inch. When the difference in slump does exceed one (1) inch, procedure and equipment used in producing the concrete shall be adjusted to reduce the difference in slump to not more than one (1) inch.

Class P.C.A.A. concrete shall have a minimum twenty-eight (28) day compressive strength of four thousand (4,000) p.s.i. The twenty-eight (28) day compressive strength requirement will be evaluated for design requirements in accordance with the "statistical evaluation of concrete strength" provisions of subsection 501.02.04 of these specifications except that for trial batch approval, the average compressive strength of five (5) standard six (6) inch by twelve (12) inch cylinders, taken from a single batch and tested at twenty-eight (28) days, shall be twenty (20) percent greater than the specified twenty-eight (28) day compressive strength and no individual cylinder shall have a strength less than the specified strength.

Compressive strength tests made for acceptance will be evaluated by the method set forth in subsection 501.02.04 "Concrete Making Properties."

409.03.02 Equipment. (a) General. Equipment and tools necessary for handling materials and performing all parts of the work must meet the approval of the Engineer as to design, capacity, and mechanical condition. This equipment shall be on the site, available for inspection, testing, and approval before paving operations are started. All equipment, tools, and machinery shall be maintained in a satisfactory working condition.

The Contractor shall provide equipment of such capacity that the paver will operate continuously or at a constant rate of production insofar as feasible. In the event that any piece of equipment does not have sufficient capacity to keep pace with the other operations, the Engineer may limit the size of the batch or otherwise limit the rate of production to prevent poor workmanship, overloading of equipment, or frequent delays.

Any equipment operating entirely or partially on the pavement, regardless of the age of the pavement, shall be equipped so that only rubber-tired wheels will come in contact with the pavement.

(b) Batch Plant and Equipment. When the size of the batch of concrete aggregates to be mixed exceeds one (1) cubic yard, the Contractor shall install and maintain in operating condition, an electrically actuated moisture meter that will indicate on a readily visible scale, the percentage of moisture in the fine aggregate as it is batched within a sensitivity of one-half (½) percent by weight of the fine aggregate.

For all batches with a volume of one (1) cubic yard or more, the batching equipment shall conform to one (1) of the following combinations:

1. Separate boxes and separate dial or beam scales for weighing each size of aggregate.
2. Single box and dial or multiple beam type scales for all aggregates.
3. Single box or separate boxes and automatic weighing mechanism for all aggregates.

In order to check the accuracy of batch weights, the gross weight and tare weight of batch trucks, truck mixers, and truck agitators shall be determined when ordered by the Engineer. The equipment shall be weighed at the Contractor's expense on scales approved by the Engineer.

Aggregates and bulk cement for use in pavement shall be proportioned by weight by means of automatic proportioning devices of approved type conforming to the requirements specified herein.

Bulk cement shall be weighed on scales separate and distinct from the

aggregate hopper or hoppers. The discharge mechanism of the bulk cement hopper shall be interlocked against opening before the full amount of cement is in the hopper, against closing before the contents of the hopper are entirely discharged and the scales are back in balance, and against opening when the amount of cement in the hopper is either over or under weight by more than one (1) percent of the amount specified.

The bulk cement batcher and aggregate batcher shall be so interlocked that a new batch of cement cannot be started until all weigh hoppers are empty, the scale at zero (0), and the discharge gates closed. The interlock shall permit no part of the batch to be discharged until all aggregate hoppers and the cement hopper are charged with the correct weight.

The discharge gate on the cement hopper shall be so designed to permit regulating the flow of cement into the aggregate as approved by the Engineer.

Material discharged from the several bins shall be controlled by gates or by mechanical conveyors. The means of withdrawal from the several bins, and of discharge from the weigh box, shall be so interlocked that not more than one (1) bin can discharge at a time; that the order of discharge can be changed; and that the weigh box cannot be tripped until the required quantity from each of the several bins has been deposited therein. Should a separate weigh box be used for each size of aggregate, all may be operated and discharged simultaneously.

When the discharge from the several bins is controlled by gates, each gate shall be actuated automatically so that the required weight is discharged into a weigh box, after which the gate shall automatically close and lock.

The automatic weighing device of the dial or multiple beam scale shall be so designed that the number of proportions required may be set on the dial or dial control and beams at the same time, and that proportions and the sequence of weighing individual sizes may be changed without delay.

It is the intention of this specification that the device shall be automatic to the extent that the only manual operation required for proportioning the aggregates and cement for one (1) batch shall be a single operation of a switch or a starter.

The batch plant shall be equipped with a numerical printout device that will make a continuous, permanent, and accurate record of the weights of cement, gravel, and sand as well as the amount of water and additives used in each batch of concrete. The record shall be given to the Engineer at the end of each production day and shall become the property of the Department at no additional expense.

The Contractor shall provide a stable platform with canopy from which the inspector can step onto the bed of the trucks in order to take samples. It shall be located no farther than two hundred fifty (250) feet from the mixer. The platform shall have a height equal to the height of the truck beds and shall be at least thirty-five (35) feet long and eight (8) feet wide with an eight by eight by eight ($8\times8\times8$) foot lockable insulated shed at one (1) end for cylinder storage. The platform shall have adequate railing and stairs with handrail down to ground level. The platform may be constructed of either wood or steel, and shall conform to the standards contained in "Safety and Health Regulations for Construction" of the Department of Labor. The lockable insulated shed shall be temperature controlled in order to maintain the

concrete test cylinders within the temperature range required by Test Method No. Nev. T428. The Contractor shall supply potable running water to the platform and one hundred ten (110) volt electrical power, suitable lights, vibrators, and outlets. The Contractor shall also furnish radios and telephones so the inspector on the platform can communicate with the batch plant operator.

(c) Mixers. All mixing equipment shall meet the provisions set forth in subsection 501.03.06, "Machine Mixing."

(d) Finishing Equipment. Vibrators. The rate of vibration shall be not less than three thousand five hundred (3,500) vibrations per minute for surface vibrators and five thousand (5,000) vibrations per minute for internal vibrators. The amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than one (1) foot from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

Vibrators shall not rest on new pavements or side forms. Power to the vibrators shall be so connected that vibration will cease when the forward or backward motion of the machine is stopped.

(e) Concrete Saw. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel to the required dimensions and at the required rate. The Contractor shall provide at least one (1) standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations.

(f) Forms.

1. Side Form. Metal side forms shall be used exclusively and shall weigh, not including stakes, not less than eighteen (18) pounds per linear foot for pavement sixty-seven one-hundredths (0.67) foot thick, not less than twenty (20) pounds per linear foot for pavement seventy-five one-hundredths (0.75) foot thick, and not less than twenty-two (22) pounds per linear foot for pavement eighty-three one-hundredths (0.83) foot thick.

For pavement edges more than sixty-seven one-hundredths (0.67) foot thick, the forms used for sixty-seven one-hundredths (0.67) foot pavement may be built-up by rigidly attaching a metal section to either the top or the bottom of the form, or both. The attachment and form shall act as a rigid unit and shall conform to the weight requirements above for the dimension of the built-up unit. The width of the base shall be equal to sixty-seven one-hundredths (0.67) foot or to eighty (80) percent of the specified thickness of the pavement, whichever is the greater.

Side forms shall be of such section and of sufficient rigidity, both in the form and in the interlocking connection with the adjoining forms, that springing will not occur under the weight of the subgrading and paving equipment or from the pressure of the pavement when placed. The Contractor shall provide sufficient forms so that there will be no delay in placing the pavement due to lack of forms.

Side form sections shall be straight, free from warps, bends, indentations, or other defects. Defective forms shall be removed from the work.

2. Slip Form. Slip-form paving equipment shall be equipped with travelling side forms of sufficient dimensions, shape, and strength to support

the concrete laterally for a sufficient length of time during placement to produce pavement of the required cross section.

No abrupt changes in longitudinal alignment of the pavement will be permitted. The horizontal deviation shall not exceed one-tenth (0.1) foot from the alignment established by the Engineer.

(g) Vibrators for Testing Purposes. The Contractor shall provide adequate internal vibrating equipment, including power, to enable state forces to perform tests. The internal vibrators shall conform to the following requirements:

Internal vibrators may have rigid or flexible shafts, preferably powered by electric motors. The frequency of vibration shall be seven thousand (7,000) vibrations per minute or greater while in use. The outside diameter or the side dimensions of the vibrating element shall be at least three-fourths (3/4) inch and not greater than one and one-half (1 1/2) inches. The length of the shaft shall be at least twenty-four (24) inches.

Vibrating equipment shall not be measured or paid for directly but the cost thereof shall be considered included in the contract unit price bid for other items of work and no further compensation shall be allowed therefor.

409.03.03 Preparation of Grade. Unless otherwise provided in the contract documents, concrete pavement shall be placed on a cement treated base conforming to the provisions of Section 304, "Portland Cement Treated Base."

The subgrade shall be moist at the time of placing concrete. Sprinkling shall be such that mud and pools of water will not be formed. At the time of placing the concrete, the grade shall not be muddy, soft, or frozen.

409.03.04 Setting Forms. Before placing side forms, the underlying material shall be at the proper grade. Side forms shall have full bearing upon the foundation throughout their length and width of base and shall be placed to the required grade and alignment of the edge of the finished pavement. They shall be so supported that they will not deviate vertically at any time more than one one-hundredth (0.01) foot from the grade established by the Engineer.

The maximum vertical deviation of the top of any side form, including joints, shall not exceed one one-hundredth (0.01) foot from a twelve (12) foot straightedge, nor shall the inside face vary more than two one-hundredths (0.02) foot from a twelve (12) foot straightedge. Stake pockets and interlocking devices shall be in such condition that they will prevent movement of the form.

Side forms shall be staked firmly by means of steel stakes at each end of the section and at intermediate points not more than five (5) feet apart and shall be so designed that stakes may be driven through the base of the form. Forms shall be provided with means for locking stakes in position. Side form sections shall be laid with an expansion gap of approximately one one-hundredth (0.01) foot. The stakes used in staking side forms shall be of sufficient length so that the side forms will be held firmly in place. Any lateral movement of forms greater than two one-hundredths (0.02) foot while supporting moving equipment shall be considered as evidence that the steel stakes

do not hold the side forms firmly in place and longer stakes shall be provided by the Contractor at his expense.

Immediately in advance of placing pavement and after all subgrade operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing the pavement.

Side forms shall remain in place until the day after placing the pavement, and in all cases until the edge of the pavement no longer requires the protection of the forms.

Side forms shall be thoroughly cleaned and oiled each time they are used and before pavement is placed against them.

409.03.05 Reinforcement. Concrete pavement shall be reinforced at structure approaches and other locations as shown on the plans or directed by the Engineer, and as specified in this section.

Bar reinforcement shall conform to the provisions in Section 505, "Reinforcing Steel."

Bar reinforcement shall be held accurately and firmly in position during the placing and compacting of the concrete without sagging by means of supporting devices which shall be left in place. The supports shall be specifically manufactured for the purpose and each support shall be capable of supporting a vertical load of two hundred (200) pounds.

409.03.06 Mixing. Mixing of concrete shall conform to the provisions in subsections 501.03.06, "Machine Mixing," and 501.03.08, "Retempering," and in addition thereto shall meet the following requirements.

Suitable nonresettable batch counter shall be provided and maintained in proper operating order, which will correctly indicate the number of batches proportioned at the batching plant and mixed in the mixers.

All concrete shall be homogeneous and thoroughly mixed in appearance, and there shall be no lumps or other evidence of undispersed cement.

Concrete mixed at the site of the work or in a central mixing plant shall be mixed not less than sixty (60) seconds or more than ninety (90) seconds. The actual mixing time shall be determined by the Engineer. Mixing time shall begin upon completion of charging of all materials into the mixing drum. Mixing time ends when mix discharge begins. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first fifteen (15) seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

409.03.07 Placing Concrete. The Contractor shall make adequate advance arrangements for preventing delay in delivery and placing of the concrete. An interval of more than forty-five (45) minutes between placing of any two (2) consecutive batches or loads shall constitute cause for stopping

paving operations and the Contractor shall make a contact joint at his expense at the location and of the type directed by the Engineer, in the concrete already placed.

Unless otherwise specified, concrete pavement shall be placed in twelve (12) foot traffic lane widths separated by contact joints as shown on the plans, or, at the option of the Contractor, the concrete pavement may be placed monolithic two (2) or more lanes wide without a contact joint, but with a longitudinal weakened plane joint at each traffic lane line.

All concrete shall be used while fresh. The use of water for retempering any concrete will not be permitted.

Any concrete showing improper proportions of materials, including water, shall not be used in the pavement and any such unsatisfactory concrete shall be removed and disposed of by the Contractor at his expense.

The Contractor shall protect freshly placed concrete from damage by any cause and any damage shall be repaired by the Contractor at his expense.

Expansion joint material shall be protected while depositing fresh concrete adjacent thereto.

Concrete work shall be adequately barricaded in all directions to protect the work.

Equipment that damages the cement-treated base, as judged by the Engineer, will be prohibited from travelling thereon.

409.03.08 Spreading, Compacting, and Shaping. (a) Side Form Construction. The concrete shall be distributed uniformly with a mechanical spreader.

The spread concrete shall be vibrated, screeded, and tamped by a machine or machines.

The concrete, for the full paving width, shall be vibrated by means of surface vibrators with internal vibrators adjacent to each longitudinal edge or by some other method of vibration that produces equivalent results without segregation.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to the progress of the mixer. Any delay in excess of fifteen (15) minutes in vibrating, screeding, and tamping shall constitute cause for stopping the mixer until the machines performing such work are again in proper position in the paving train.

Screeding and tamping shall be performed by making at least two (2) complete passes over the entire area of the pavement. On the first pass, the tamper shall be adjusted to produce the proper tamping action and the tamping bar shall not be operated during the second pass unless otherwise directed by the Engineer. The screeds shall be adjusted to an elevation slightly above grade so that when properly consolidated and finished, the completed surface of the pavement will be at the established grade, true to the cross section shown on the plans, and free from porous areas. The tops of the forms or the adjacent pavement and the contact surface of the crawler tracks or wheels shall be kept clean by effective devices attached to the machine. The travel of the machine shall be maintained true without lift, wobble, or other variation tending to affect precision screeding. The machine shall be of ample strength to withstand severe use and shall be fully and accurately adjustable to

compensate for wear. During each pass of the machine, a roll of concrete shall be maintained ahead of the front screed for the entire width of pavement being placed and except when making an expansion joint, the machine shall not be operated beyond that point where the roll of concrete can be maintained. The intent of this specification is that the equipment shall produce a surface requiring minimum cutting during the floating and final finishing as specified in subsection 409.03.10, "Finishing."

Concrete required to be placed in widths less than a traffic lane may be compacted and shaped by a powered mechanical compacting and shaping machine, supplemented by hand methods as necessary. Where hand compaction is performed, the tamper shall be constructed of heavy plank which length exceeds the width of pavement by a minimum of one (1) foot; shall be shod with a heavy strip of metal for a tamping surface; and shall be stiffened adequately to maintain the required shape during use. For concrete production in excess of forty (40) cubic yards per hour, and where all compaction is performed by hand methods, not less than two (2) tampers shall be used.

The hand tamper shall be used with a combined tamping and longitudinal motion raising it from the side form and dropping it to consolidate the concrete. A surplus of concrete shall be kept in front of the hand tamper and tamping shall continue until the required cross section is obtained and the mortar flushes slightly to the surface.

Where hand compaction is performed on grades in excess of five (5) percent, a light strike board constructed similar to the heavy tamper shall be used following the heavy tamper or tampers to correct any displacement caused by flow of the concrete.

(b) Slip-Form Construction. The Engineer shall establish references at reasonable intervals on both sides of the roadway, for line and grade control of the placing operations. The Contractor shall furnish, place, maintain, remove, and dispose of such supports, wire devices, and materials as may be required to provide continuous line and grade reference controls to the placing machine or paver. The slip-form paver shall be equipped with a control system which will automatically sense and simultaneously control the laying or trimming of the materials to the specified longitudinal and lateral grade, from both sides of the roadway. The control systems shall be automatically actuated from an independent line, and grade control references through a system of mechanical sensors or sensor directed devices which will maintain the equipment at the proper transverse slope and at the proper elevation to obtain the required thickness and surface. The material placed shall be subject to the smoothness and thickness tolerances specified in each of the respective specifications.

Slip-form paving equipment shall spread, consolidate, screed, and float-finish the freshly placed concrete in such a manner that a minimum of finishing with a hand float, as specified herein, will be required to provide a dense and homogeneous pavement.

The concrete shall be distributed uniformly into final position by the slip-form paver without delay.

The concrete, for the full paving width, shall be effectively consolidated by internal vibration with transverse vibrating units or a series of equally spaced longitudinal vibrating units. If a series of longitudinal vibrating units are used,

they shall be equally spaced at intervals not to exceed two and one-half (2½) feet, measured center to center.

The term "internal vibration" specified in the above paragraph shall be construed to mean vibration by means of vibrating units located within the specified thickness of pavement section and a minimum distance ahead of the screed equal to the pavement thickness.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface shall be offset to run a sufficient distance from the edge of the pavement to avoid breaking or cracking the pavement edge.

At locations inaccessible to slip-form paving equipment, concrete pavement shall be placed by methods and equipment conforming to the requirements for placing concrete in widths less than a traffic lane, as specified in subsection 409.03.08(a), "Side Form Construction." At such locations, the use of stationary side forms conforming to subsection 409.03.02(f)1, "Side Form," will be required. Locations inaccessible to the slip-form paving equipment shall be finished by the hand float method and equipment specified in subsection 409.03.10(c), "Hand Float Method."

409.03.09 Joints. (a) General. Joints in pavement will be designated as longitudinal and transverse contact joints, transverse expansion joints, and longitudinal and transverse weakened plane joints, and shall be constructed as shown on the plans and in accordance with the following provisions.

All transverse joints shall be constructed at the angle to the centerline of the pavement shown on the plans, and the faces of all joints both transverse and longitudinal shall be normal to the surface of the pavement.

All sawed joints shall be clean and free of all foreign material after completion of shoulder work and prior to acceptance of the contract.

Bent tie bars shall be bent at right angles approximately four (4) inches from one (1) end to form a support resting on the subgrade. The free end of the bar shall be bent along the side form so as to lie parallel to the pavement edge. After the first lane of pavement is completed, the bar shall be straightened to the proper position before paving the adjoining lane. If an "S" shaped bend is formed in straightening the bar, the offset from a straight line shall not be more than one-tenth (0.1) foot.

Straight tie bars shall be placed mechanically to a uniform depth of thirty-three one-hundredths (0.33) foot for the longitudinal contact joints.

Tie bars shall be required for all contact joints and shall be placed as specified in this subsection and as indicated on the plans. Tie bars will not be required in longitudinal weakened plane joints in multi-lane monolithic pavement or in transverse weakened plane joints.

Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or in lieu of bent tie bars, approved two (2) piece connectors may be used.

(b) Contact Joints. Contact joints are those made by placing fresh concrete against hardened concrete at planned locations.

Concrete on both sides of longitudinal contact joints shall be connected with tie bars as shown on the plans.

When the plans require the construction of keyways, the groover portion of the keyway shall be constructed as part of the pavement width being placed.

(c) Weakened Plane Joints. Sawed transverse weakened plane joints shall be formed by cutting the pavement with a power driven saw at the locations shown on the plans. The grooves for transverse weakened plane joints shall be saw cut to the dimensions shown on the plans for "transverse weakened plane joint, double saw cut." Sawed longitudinal weakened plane joints shall be formed by cutting the pavement with a power driven saw at all lane lines and except as hereinafter provided, all shoulder lines. Where the combined width of the P.C.C.P. shoulder and adjacent lane is sixteen (16) feet or less, the longitudinal joint shall be omitted between the shoulder and the lane. The grooves for longitudinal weakened plane joints shall be saw cut to the dimensions shown on the plans for "longitudinal weakened plane joint, single saw cut." The sawed joint shall go through the pavement edge at full depth of cut. Every fourth planned transverse weakened plane joint in the initial lane of concrete and also the first joint immediately after the transverse contact joint shall be sawed within twenty-four (24) hours after the concrete has been placed, unless otherwise permitted by the Engineer, the exact time to be determined by the Engineer. Every second planned transverse weakened plane joint shall be sawed within forty-eight (48) hours after placing the concrete, unless otherwise permitted by the Engineer, the exact time to be determined by the Engineer. The remaining longitudinal and transverse weakened plane joints may be sawed at such time, after twenty-four (24) hours, as the Contractor may elect, except they shall be completed before placing concrete in succeeding adjacent lanes and before permitting the Contractor's traffic or public traffic to use the pavement.

In succeeding lanes of the concrete pavement, transverse joints opposite those which have opened in the initial lane shall be sawed within twenty-four (24) hours after the concrete has been placed, the exact time to be determined by the Engineer, but in all cases not more than three (3) consecutive planned transverse weakened plane joints may be sawed at such time, after twenty-four (24) hours, as the Contractor may elect, except they shall be completed before placing concrete in the succeeding adjacent lane and before permitting the Contractor's traffic or public traffic to use the pavement.

No sawing shall be done where volunteer transverse cracks exist. If a volunteer transverse crack falls within five (5) feet of the location of a proposed sawed joint, the sawed joint shall be omitted. Joints sawed in violation of the provisions in this paragraph will not be paid for.

When the pavement is cured by means of a curing seal, all portions of the seal which have been disturbed by sawing operations shall be restored by spraying the areas with additional curing seal.

The Contractor shall keep a standby power saw on the project at all times when concrete paving operations are under way.

Sawed longitudinal and transverse weakened plane joints shall be sealed with joint sealant material specified in subsection 707.03.07 of these specifications. The joint shall conform to the details shown on the plans and to the

requirements of these specifications. Prior to sealing, the joint shall be cleaned by jet waterblasting. Immediately prior to sealing, joints shall be blown using a minimum air pressure of one hundred (100) p.s.i. All joints shall be clean and dry prior to sealing. Prior to placing the joint sealer, a commercial quality nonabsorptive bond breaker cord shall be placed in the joint to the depth shown on the plans. The joint sealer material shall be installed in accordance with the manufacturer's recommendations.

It shall be the Contractor's responsibility to prevent spills or excess sealer material from coming in contact with the horizontal surface of the concrete pavement on either side of the joint and any such spills or excess material shall be removed to the satisfaction of the Engineer at the Contractor's expense.

(d) Transverse Expansion Joints. Transverse expansion joints shall be formed at structure approaches as shown on the plans and as specified herein.

Transverse expansion joints shall be formed by means of joint filler strips conforming to the provisions in Section 707, "Joint Materials," and placed as specified herein. The joint strips shall be firmly supported in position by metal holders and end supports. The supports shall be held firmly in position and shall remain in place after completion of the pavement.

The metal holders shall be fabricated of sheet steel not less than sixteen (16) gage. They shall be in the form of a deep channel, extending down on both sides of the joint strip to a depth of not less than thirty-seven one-hundredths (0.37) foot. They shall be slotted and cut away as necessary, to allow the concrete to make contact with the joint strip at close intervals. The ends of the holders shall be spread to admit the end supports.

During placing and compacting the concrete, the joint holder and end supports shall be so secured as to insure against movement of the joint strip and to keep the top edge of the joint strip approximately four one-hundredths (0.04) foot below the surface of the finished pavement. After the concrete has been placed and compaction completed, the metal holder may be removed and a suitable shallow metal channel substituted therefor which shall fit snugly over the top edge of the joint strip and shall remain there until the joint is edged.

Filler shall extend the full width of the concrete being placed less four one-hundredths (0.04) foot and after the side forms have been removed, any concrete which has flowed around the ends of the joint filler shall be removed.

This work shall also include furnishing and installing "preformed polyethylene joint filler" in the concrete pavement in accordance with the details shown on the plans and as hereinafter specified.

The new concrete pavement shall be saw cut at locations shown on the plans for placement of the polyethylene joint filler. Forming of the open joint and subsequently removing the forms to allow placement of the joint filler will not be permitted. The joint shall be saw cut full width of the concrete pavement and full depth and shall be four (4) inches wide with a tolerance of plus zero (0) inches and minus one-eighth (1/8) inch between joint faces. Remove all concrete between the cuts and thoroughly clean the open joint with compressed air.

The height of the polyethylene joint filler shall be such that the top surface

of the installed filler is one-half (½) inch below the finished surface of the concrete pavement. The width of the joint filler shall be four (4) inches. Prior to inserting the filler into the open joint, all sides of the material which will be in contact with concrete shall be coated with a joint lubricant and adhesive recommended by the manufacturer of the filler material.

The polyethylene joint filler material shall conform to the following requirements:

The material shall be black, flexible, low density, expanded extruded polyethylene plank formed by the expansion of polyethylene base resin, extruded as a multicellular, closed cell, homogeneous foamed polyethylene. Laminations will not be permitted.

The joint material shall conform to the following physical property requirements:

Compression, p.s.i. when tested in accordance with ASTM Designation D1056 except that compressive strength shall be determined at ten (10) percent and eighty (80) percent deflection:

At 10 percent deflection	less than 10
At 80 percent deflection	less than 125

Water absorption when tested in accordance with ASTM Designation C272 using conditioning procedure 4.1.1 at a temperature of fifty (50) plus or minus three (3) degrees Centigrade:

Percent by volume	less than 0.5
Density when tested in accordance with ASTM Designation D1564:	
Pounds per cubic foot	2.6 ± 0.2

Size: Thickness shall be four (4) inches, plus one-half (½) inch, minus zero (0) inch. Width shall be sufficient to fill the joint without laminating to within one-half (½) inch below the finished surface of the concrete pavement.

The Contractor may, at his option, substitute a cellular plastic joint filler in lieu of the polyethylene filler. The cellular plastic filler shall conform to the following requirements:

Density when tested in accordance with ASTM Designation D3574:	
Pounds per cubic foot	7–10

Compressive strength, p.s.i. when tested in accordance with ASTM Designation D3574:

At 25 percent deflection	3–10
At 65 percent deflection	8–25

Tensile strength when tested in accordance with ASTM Designation D3574:

p.s.i. minimum	25
Recovery, percent minimum (Note 1)	95

Note 1: Sixty-five (65) percent deflection recovery calculated after one (1) minute of relaxation from deflection return.

The width of the cellular plastic joint filler shall be five (5) inches prior to insertion into the four (4) inch concrete joint. The height of the plastic filler shall conform to the requirements of this subparagraph of these specifications

for polyethylene joint filler. In the event spacers are required beneath the joint filler to obtain the proper height (one-half (1/2) inch below the finished concrete surface), the spacers shall be placed full length of the filler and shall consist of commercial quality rigid polystyrene or polyethylene foam or other easily compressible type material approved by the Engineer.

The cellular plastic joint filler shall be so designed as to create a self-locking action when compressed into the joint and shall be coated with a lubricant adhesive as recommended by the joint manufacturer. In the event the joint material is furnished in less than full joint width lengths, adhesive shall be applied to the ends to be joined.

Regardless of the type joint filler used, the joint shall be clean and free from all loose material, dirt, dust, grease, oil, or other foreign matter and shall be smooth and surface dry prior to installation of the filler.

409.03.10 Finishing. (a) General. Unless adequate lighting facilities are provided by the Contractor, placing of concrete shall cease at such time so that finishing operations can be completed during daylight hours.

Necessary workmen shall remain at work long enough to complete the finishing and curing of the pavement.

At the start of each day's work, the Contractor shall mark at the edge of the pavement nearest the outside shoulder with an approved stamp, his name, the month, day, and year such section is placed, and the Engineer's station fifty (50) feet back from the location of the joint. The stamp shall be approximately one (1) foot by two (2) feet in size and shall be furnished by the Contractor and the cost thereof will be included in the paving items.

In case fine cracks or hair checks appear in newly placed concrete before it is thoroughly set, water shall be applied to the concrete surfacing, in the form of a fine fog mist, until the finishing operations are completed and the curing is applied.

In advance of curing operations the concrete pavement shall be first textured with a drag strip of burlap and then with a mechanical spring steel tine device which will form grooves transversely to the centerline. The tines shall be rectangular in cross section, three thirty-seconds (3/32) to one-eighth (1/8) inch wide and four (4) to five (5) inches long. Tines shall be spaced one and one-half (1 1/2) inches center to center and be of sufficient thickness and resilience to result in grooves one-eighth (1/8) to one-fourth (1/4) inch deep in the finished concrete pavement.

The speed of the tine machine shall be slow enough so that the tines will penetrate the surface to the desired depth, yet fast enough so the machine can keep up with paving operations.

A one (1) inch gap shall be left between each tine strip to prevent overlapping the tined surface and producing a weak surface area.

(b) Machine Float Method. The surface of the concrete shall be finished smooth and true to grade by means of a machine float.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to the progress of the mixer. Any delay in excess of thirty (30) minutes in performing the preliminary finishing shall constitute cause for stopping the mixer until the machine or machines performing such work are again in proper position in the paving train.

The machine float shall be self-propelled and designed to run on the side forms, adjacent lanes of concrete, or the base surface. When the machine float runs on the adjacent pavement, the pavement shall be protected as specified in subsection 409.03.02(a), "Equipment—General." The floats shall be of such length and shall be set at angles with the axis of the machine so as to effectively spread and smooth the surface of the concrete, full width being placed, eliminating unevenness and producing a surface texture of uniform appearance. The machine shall be equipped with a suitable water tank and spraying device designed to spray water in a fine mist on the concrete surface as directed by the Engineer. The machine shall be capable of operating at speeds adequate to perform all finishing operations necessary. The speed of operation shall be such as to give the best results. Alternative equipment may be substituted for the equipment provided for in this section, provided the finished surface conforms to the provisions specified herein.

(c) Hand Float Method. The surface of the concrete shall be finished smooth and true to grade with two (2) wooden floats sixteen (16) feet long, one (1) inch thick and four (4) inches wide, rigidly ribbed and with adjusting screws between the rib and float bars at not more than two (2) foot centers, to insure a true and flat surface on the under side at all times. Each float shall be operated from the side of the pavement and the float shall be parallel with the centerline of the pavement. The edge of the float shall be used to cut down all high areas, and the material so removed shall be floated into the depressions until a true surface is obtained. Each successive passage of the float shall just lap the previous path. Upon completion of the passage, the float shall be brought back and the overlap between the two (2) passages smoothed.

The floats shall be operated as far back of the tamping machine as the concrete remains workable and the number of passes shall be sufficient to remove all perceptible inequalities.

At least one (1) spare float in good condition shall be available on the work at all times.

(d) Final Finish. After the preliminary finishing has been completed, the edges of an initial pavement lane shall be rounded to a one-half (1/2) inch radius. Transverse contact joints, expansion joints, and joints adjacent to an existing pavement shall be rounded to a one-fourth (1/4) inch radius.

In advance of the curing operations, or as directed by the Engineer, the pavement shall be textured with a drag strip of burlap or other device which will produce scoring parallel to the centerline. The burlap drag shall consist of one (1) or more pieces of burlap fastened to a cross member riding on the subgrade or side forms by means of wheels or skids to form a continuous strip of burlap the full width of the pavement. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted. Completed pavement that is found to have a surface texture which, in the opinion of the Engineer, would not provide satisfactory skid resistance, shall be ground or scored by abrasive means by the Contractor, at his expense, to provide a surface texture satisfactory to the Engineer.

409.03.11 Riding Tolerances. Upon completion of the pavement, any points that are high in excess of the straightedge tolerances set forth in

subsection 409.02.03, "Concrete Properties and Tests," shall be removed by abrasive means as provided in this section.

Equipment that consistently produces a finished surface having a profile index of seven (7) inches per mile or less, shall be used. Should the profile index exceed the rate of seven (7) inches per mile, the paving operations shall be discontinued until other means and equipment are proposed for trial by the Contractor and are approved by the Engineer. Such revised methods and equipment shall be discontinued if they do not produce a finished surface having a profile index of seven (7) inches per mile or less. Operations shall not be resumed until the Engineer approves further changes in methods and equipment as proposed by the Contractor.

In addition to the requirement for average profile index, all areas representing high points having deviations in excess of three-tenths (0.3) inch as defined in the following paragraph, shall be reduced by abrasive means until such deviations as indicated by reruns of the profilograph do not exceed three-tenths (0.3) inch. The deviations in excess of three-tenths (0.3) inch shall be determined by measurement of the profilogram in accordance with Test Method No. Nev. T446.

After grinding has been completed to reduce all individual deviations in excess of three-tenths (0.3) inch as provided in the above paragraph, additional grinding shall be performed if necessary to reduce the profile index, as measured by the profilograph to seven (7) inches per mile, or less, in any one-tenth (0.1) mile section along any line parallel to the edge of the pavement.

Additional grinding shall be performed as necessary to extend the ground area laterally to the nearest lane line or edge of pavement and longitudinally so that the grinding begins and ends at lines normal to the pavement centerline within any one (1) ground area. It is the intent of this requirement that all ground areas be neat rectangular areas of uniform texture.

When grinding operations are required in order to meet the riding tolerances of this subsection, and once these tolerances have been met, the areas so involved shall be then regrooved as directed by the Engineer to meet the requirements of subsection 409.03.10 of these specifications for a tined surface finish.

The profile index requirements herein will not apply to the pavement within thirty (30) feet of either end of a bridge. The finished surface of such pavement shall, however, meet all other requirements in this section.

409.03.12 Curing. (a) General. All Portland cement concrete pavement must be cured for seventy-two (72) hours by the method specified in this section, subject to the conditions set forth in subsection 501.03.09(a), "Curing—General." In case of low temperatures, the curing period will be increased according to the provisions of subsection 501.03.10(b), "Cold Weather—General."

(b) Curing Compound Method. Except as modified herein, curing by use of curing compound shall be as specified in subsection 501.03.09(c), "Curing Compound Method." The curing compound shall not be applied until all patching and surface finishing, except grinding, has been completed. When deemed necessary by the Engineer during periods of hot weather, fogging of the concrete with water shall be continued after curing compound is applied

until the Engineer determines that a cooling effect is no longer required. Such fogging after the application of the curing compound will be paid for as extra work as provided in subsection 104.03, "Extra Work."

All Portland cement concrete pavement shall be cured with a white pigmented curing compound applied in two (2) approximately equal applications. The second application shall be applied in the opposite longitudinal direction as the first and not more than thirty (30) minutes shall elapse between applications. At the Contractor's option, the curing compound may be either a white pigmented curing compound or a white pigmented curing compound-chlorinated rubber base conforming to the requirements of Section 702 of these specifications. Surfaces of the concrete pavement which are exposed to the air shall be sprayed uniformly so as to obtain total coverage of the concrete surfaces. The rate of each application of white pigmented curing compound, at any point, shall be one (1) gallon per two hundred (200) sq. ft., plus or minus fifty (50) sq. ft., and the average rate of each application shall be one (1) gallon per two hundred (200) sq. ft., plus or minus twenty-five (25) sq. ft. The rate of each application of white pigmented curing compound-chlorinated rubber base, at any point, shall be one (1) gallon per two hundred fifty (250) sq. ft., plus or minus fifty (50) sq. ft., and the average rate of each application shall be one (1) gallon per two hundred fifty (250) sq. ft., plus or minus twenty-five (25) sq. ft. Power operated spraying equipment for application of curing compound shall be equipped with an operational pressure gage and means of controlling the pressure.

The compound shall be applied immediately after the moisture sheen begins to disappear from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any delay in the application of curing compound, application of water with an atomizing nozzle as specified in subsection 501.03.09(b), "Water Method," shall be started immediately and shall be continued until the application of the compound is resumed or started. Should the film of compound be damaged from any causes before the expiration of seventy-two (72) hours after the concrete is placed, the damaged portion shall be repaired immediately with additional compound.

(c) Waterproof Membrane Method. Curing by use of waterproof membrane material shall be as specified in subsection 501.03.09(d), "Waterproof Membrane Method."

409.03.13 Protection of Pavement. Concrete shall not be placed on frozen ground nor shall it be mixed or placed while the atmospheric temperature is below thirty-five (35) degrees Fahrenheit, unless adequate means are employed to heat the aggregates and water, and provision satisfactory to the Engineer has been made for protecting the work.

Placing concrete shall be stopped before the quantity of rainfall is sufficient to cause a flow or wash the surface.

Upon written notice from the Engineer, all concrete which has been damaged shall be replaced by the Contractor at his expense.

All concrete in pavement shall be protected from freezing or frost for a period of five (5) days after placing. The temperature of the surface of the concrete shall not be allowed to drop below forty (40) degrees Fahrenheit for this period of five (5) days.

When ordered by the Engineer or shown in the contract documents, pavement crossings shall be constructed for the convenience of public traffic. The material and work necessary for the construction of such ramps, and their subsequent removal and disposal, will be paid for at the contract unit prices for the items of work involved and if there are no contract items for the work involved, payment for pavement crossings will be made by force account work as provided in subsection 104.03, "Extra Work." Where public traffic will be required to cross over the new pavement, Type III Portland cement shall be used in concrete. When Type III Portland cement is used in concrete, and if permitted in writing by the Engineer, the pavement may be opened to traffic as soon as the concrete has developed a modulus of rupture of five hundred fifty (550) pounds per square inch.

No traffic or Contractor's equipment, except for subgrading equipment, will be permitted on the pavement before a period of ten (10) calendar days has elapsed after the concrete has been placed, nor before the concrete has developed a modulus of rupture of at least five hundred fifty (550) pounds per square inch, as determined by Test Method No. Nev. T442. Concrete that fails to attain a modulus of rupture of five hundred fifty (550) pounds per square inch within ten (10) days shall not be opened to traffic until directed by the Engineer.

Equipment used to prepare subgrade may be permitted to ride upon one (1) edge of the previously placed concrete at the end of seventy-two (72) hours, provided, however, that no damage is done to the pavement edge by reason of such operation. Any damage to the pavement resulting from such operations shall be repaired by the Contractor at his expense prior to placing the adjacent lane.

METHOD OF MEASUREMENT

409.04.01 Measurement. The number of square yards of concrete pavement to be measured for payment will be determined from horizontal measurements of the completed finished surface of the pavement, except that the area for payment for pavement end anchors will be determined by computing the total specified compacted volume of material in the anchors and converting such volume to an equivalent area based on the thickness of pavement placed on the travelled way.

Joint sealer and bond breaker placed in sawed transverse and longitudinal weakened plane joints shall not be measured or paid for directly but the cost thereof shall be considered included in the contract unit price bid per linear foot for the joint and no further compensation shall be allowed therefor.

The "4-inch expansion joint (saw cut)" shall be measured for payment by the linear foot.

Tie bars will not be measured for payment.

The length of sawed transverse and longitudinal weakened plane joints shall be the length in feet of the transverse and longitudinal weakened plane joints actually sawed except as otherwise provided in subsection 409.03.09(c), "Weakened Plane Joints." Volunteer cracks will not be included in the length of transverse or longitudinal weakened plane joints measured for payment.

The work of scoring the concrete shoulders as shown on the plans shall not

be measured or paid for directly but the cost thereof shall be considered included in the contract unit price bid for other items of work.

The work of grooving the concrete surface with tines will not be measured or paid for directly but the cost thereof shall be considered included in the contract unit price bid for other items of work.

409.04.02 Pavement Thickness. It is the intent of the specifications that concrete pavement shall be constructed in accordance with the thickness requirements of the plans and specifications. Tolerances allowed for subgrade construction and other specification provisions which may affect thickness shall not be construed to modify such thickness requirements.

It is agreed by the parties that compliance with the thickness requirements for concrete pavement will be determined by the Engineer in accordance with the provisions in this subsection. It is further agreed by the parties that the liability of the Contractor for failure to comply with such thickness requirements and the rights of the State in the event of such failure shall likewise be governed by the provisions in this subsection.

For the purposes of these specifications, the primary unit of pavement will be the area of pavement placed in each day's paving operations. Within such primary unit of pavement, there may be an area or areas which have been determined to be a secondary unit or units of pavement, as provided in subsection 409.04.02(b), "Thickness Deficiency of More Than Six-Tenths (0.6) Inch." In such case, the primary unit area will be reduced by the secondary unit area included therein.

At such time after the concrete pavement has been placed, as is determined by the Engineer to be appropriate, thickness measurements will be made in each primary unit of pavement at the rate of not less than one (1) measurement for each one thousand (1,000) linear feet of traffic lane, or fraction thereof, of pavement placed. The exact location and number of thickness measurements within each primary unit, both longitudinally and transversely, will be as determined by the Engineer. In general, thickness measurements will be made at approximately uniform intervals throughout each primary unit of pavement.

If required, secondary thickness measurements will be made as provided in subsection 409.04.02(b), "Thickness Deficiency of More Than Six-Tenths (0.6) Inch."

Pavement thickness variation, if any, from the thickness requirements of the plans and specifications will be determined by comparing the actual thickness measurement with the thickness specified at the location where the measurement was made. Such variation will be determined as either excess or deficient thickness.

(a) Thickness Deficiency of Not More Than Six-Tenths (0.6) Inch. If the thickness measurements in a primary unit are deficient in thickness by not more than six-tenths (0.6) inch, thickness variations in such unit will be averaged, algebraically, to determine the average thickness deficiency, if any, in said primary unit. For the purpose of determining the average thickness deficiency, an excess thickness variation of more than two-tenths (0.2) inch greater than the thickness specified will be considered to be two-tenths (0.2) inch greater than the specified thickness.

For each primary unit of pavement which is deficient in average thickness, the Contractor shall pay to the Department as liquidated damages, or the Department, at its option, may deduct from any money due, or to become due the Contractor from the Department, an amount set forth in the following schedule:

Average Thickness Deficiency (inches)	Deficiency (percent of bid price)
0.00–0.20	0
0.21–0.30	10
0.31–0.40	15
0.41–0.50	25
0.51–0.60	30

(b) Thickness Deficiency of More Than Six-Tenths (0.6) Inch. For each thickness measurement made in a primary unit by the Engineer that is deficient in thickness by more than six-tenths (0.6) inch, the Engineer will determine from secondary thickness measurements the dimensions of the secondary unit area where the apparent thickness deficiency is more than six-tenths (0.6) inch. The determination of the limits of said secondary unit area will be made by making secondary thickness measurements in each panel of pavement adjacent to the panel in which the original measurement in the primary unit was made. This procedure will continue, regardless of unit boundaries, until such secondary unit area is bounded by panels in which the secondary measurement is deficient in thickness by six-tenths (0.6) inch or less.

Panels are the areas bounded by longitudinal and transverse joints and pavement edges. If a transverse weakened plane joint has been omitted at the location where a volunteer crack exists, in accordance with the provisions in subsection 409.03.09(c), "Weakened Plane Joints," the volunteer crack will be considered as a transverse joint only if the pavement adjacent thereto is not to be removed and replaced. If either longitudinal or transverse joints, or both, are eliminated by the special provisions or plans, the limits of panels will be determined by the Engineer as if such joints had been constructed.

After eliminating the secondary unit area, or areas, and the thickness measurements therein from consideration, the average thickness deficiency, if any, of the remainder of primary unit areas will be determined as provided in subsection 409.04.02(a), "Thickness Deficiency of Not More Than Six-Tenths (0.6) Inch." Secondary thickness measurements made outside of a secondary unit area may be used to determine average thickness deficiency, if any, in the remaining primary unit area in which they are taken.

Each panel in which secondary thickness measurements are made pursuant to the provisions in this subsection will be deemed to be, in its entirety, of the thickness shown by such measurement.

After the Engineer has determined the limits of the secondary unit area, he will further determine, within such area, which panels, if any, will be required to be removed and replaced in accordance with procedure 1, below, and the panel, if any, which will remain in place in accordance with procedure 2, below.

1. The Contractor shall, at his expense, remove and replace the concrete

pavement in such panels with concrete pavement meeting the thickness and all other requirements of the contract documents. If the area to be removed is not bounded by longitudinal or transverse joints, the Contractor shall saw, at his expense, weakened plane joints at the location designated by the Engineer, conforming to the provisions in subsection 409.03.09(c), "Weakened Plane Joints." Subgrade shall be lowered as necessary to meet the full thickness requirements. Replaced pavement will be tested for thickness compliance by means of additional secondary measurements and will be subject to all of the thickness requirements of the specifications.

2. The Contractor shall leave such panels of pavement in place without payment, if they meet all of the other requirements of the contract documents.

The cost of all secondary thickness measurements made in accordance with the provisions in this subsection, including filling of any necessary holes with concrete, will be deducted from any money due, or that may become due, the Contractor under the contract.

After eliminating the secondary unit area, or areas, and the thickness measurements therein from consideration, the average thickness deficiency, if any, of the remainder of primary unit areas will be determined as provided in subsection 409.04.02(a), "Thickness Deficiency of Not More Than Six-Tenths (0.6) Inch." Secondary thickness measurements made outside of a secondary unit area may be used to determine average thickness deficiency, if any, in the remaining primary unit area in which they are taken.

The Contractor shall not be entitled to any additional compensation or extension of time due to any of the provisions in this subsection.

No additional compensation will be allowed the Contractor for any pavement constructed in excess of the thickness requirements of the contract documents.

If the Contractor believes that the number of thickness measurements made in secondary unit areas by the Engineer in accordance with the provisions in this subsection are insufficient to fairly indicate the actual thickness of pavement placed, he may request that additional thickness measurements be made by the Engineer and such additional measurements will be used in determining the average thickness variation. The location of all such additional thickness measurements will be determined by the Engineer. The cost of all such additional measurements made, including filling of any necessary holes with concrete, will be deducted from any money due, or that may become due, the Contractor under the contract.

409.04.03 Compressive Strength. In the event that the concrete placed is shown by test to be below the specified twenty-eight (28) day compressive strength, a determination shall be made by the Engineer as to whether the concrete shall be removed and replaced or allowed to remain in place. If after review, the concrete is allowed to remain in place, liquidated damages will be determined in accordance with subsection 502.04.01 of these specifications.

Price adjustments for strength and thickness will be determined separately.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

409.05.01 Payment. The accepted quantities measured as provided in subsections 409.04.01, "Measurement," and 409.04.02, "Pavement Thickness," will be paid for at the contract unit price bid per square yard for Portland cement concrete pavement, and per linear foot for saw transverse weakened plane joints.

The above prices shall be full compensation for furnishing all the material including Portland cement and water, mixing, hauling, placing, finishing, and incidentals necessary for doing all the work as shown on the plans or established by the Engineer.

Full compensation for furnishing and placing all material used in constructing transverse expansion joints at structure approaches, as indicated on the plans, shall be considered as included in the contract price paid per square yard for concrete pavement and no additional compensation will be allowed therefor.

The accepted quantity of "4-inch expansion joint (saw cut)" measured as provided in subsection 409.04.01, "Measurement," shall be paid for at the contract unit price bid per linear foot, which payment shall be considered full compensation for all sawing, removing of concrete, preparing the joint to receive the joint filler, and for furnishing and installing the cellular plastic or polyethylene joint filler complete in place in the accepted work.

The accepted quantity of sawed transverse and longitudinal weakened plane joints, measured as provided in subsection 409.04.01, "Measurement," shall be paid for at the contract unit price bid per linear foot for "saw and seal transverse weakened plane joints" and "saw and seal longitudinal weakened plane joints," which price shall be considered full compensation for sawing, cleaning, furnishing, and placing the bond breaker and the joint sealer, and for furnishing all labor, materials, equipment, tools, supplies, and incidentals necessary to construct the sealed transverse and longitudinal weakened plane joints complete in place in the accepted work.

Reinforcement, except tie bars, will be paid for as provided in Section 505, "Reinforcing Steel."

Tie bars will not be paid for directly but the cost thereof shall be considered included in the contract unit price bid for other items of work.

There shall be no direct payment for grooving the concrete surface with tines and all work involved shall be considered included in the contract bid prices for other items of work.

All grinding and regrooving of the concrete pavement that is necessary to meet the requirements of subsection 409.03.11 of these specifications shall be accomplished solely at the Contractor's expense and no additional payment will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for Portland cement concrete pavement may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Portland Cement Concrete Pavement (.... inches)	Square Yard
Concrete Paving Miscellaneous Areas (.... inches)	Square Yard
Saw and Seal Transverse Weakened Plane Joints	Linear Foot
Saw and Seal Longitudinal Weakened Plane Joints	Linear Foot
4-inch Expansion Joint (saw cut)	Linear Foot

SECTION 501

PORTLAND CEMENT CONCRETE

DESCRIPTION

501.01.01 General. This work shall consist of Portland cement, fine aggregate, coarse aggregate, water and, when specified, admixtures, proportioned, placed, and cured as herein specified.

MATERIALS

501.02.01 General. Materials shall meet the requirements of the following sections:

Water	Section 722
Aggregate for Portland Cement Products	Section 706
Portland Cement	Section 701
Concrete Curing Materials and Admixtures	Section 702

501.02.02 Gradation Requirements. The gradation requirements represent the extreme limits in determining the suitability of material. The gradation from any one (1) source shall maintain a uniformity such that variations in the fineness modulus will not exceed plus or minus two-tenths (0.2) from the fineness modulus of samples of the material offered for use. Fine aggregate from any one (1) source having a variation in fineness modulus of more than two-tenths (0.2) as prescribed above shall be rejected or, at the discretion of the Engineer, may be accepted subject to such approved changes. The fineness modulus of fine aggregate shall be determined by adding the cumulative percentages, by weight, of material retained on each of U.S. Standard sieves Nos. 4, 8, 16, 30, 50, and 100, and dividing by 100.

Fine aggregates from different sources of supply shall not be mixed or stored in the same pile. They shall not be used alternately in the same class of construction or job-mix without written permission of the Engineer. Such permission shall be contingent on amending the job-mix and batch weights as necessary to protect the quality of the concrete produced.

If the fine aggregate for a job-mix is to be a composite material from two (2) or more sources, material from respective sources shall be proportioned separately or blended by methods which will maintain the degree of uniformity or gradation required by these specifications.

Adequate supplies of aggregate shall be produced and stockpiled sufficiently in advance of construction operations as to permit sampling and testing before use.

Coarse aggregates secured from the same or different sources and which vary widely in gradation shall be placed in separate stockpiles or bins and recombined in proportions approved by the Engineer. Different sizes of aggregates shall be stored in stockpiles sufficiently removed from each other to prevent the materials at the edges of piles from becoming intermixed.

If the Contractor changes the source of any size of aggregate, opportunity shall be given in advance of use to permit the Engineer to determine the

concrete-making properties as provided in subsection 501.02.04, "Concrete Making Properties."

501.02.03 Admixtures. Air-entraining admixtures and water reducers and retarders shall conform to the requirements of subsections 702.03.03, "Air-Entraining Admixtures," and 702.03.04, "Water Reducer and Retarders."

Admixtures used in Class EA Concrete, Modified (Major) shall be an approved chemical admixture for concrete, meeting the requirements of ASTM Designation C494 and shall be added to all concrete placed in roadway deck slabs and slab spans of bridges. This admixture shall be Type "A" when the anticipated high temperature for the day is eighty (80) degrees F. or below. If the anticipated high temperature is above eighty (80) degrees F., Type "D" admixture shall be added. When either Type "A" or "D" admixture is used the maximum slump allowed will be two and five-tenths (2.5) inches. No adjustment in water-cement ratio will be allowed once the chemical admixture has been incorporated into the mix.

No admixtures shall be used without written permission from the Engineer, except as otherwise provided in these specifications or in the special provisions.

Admixtures shall not be used to replace cement. Admixtures containing chlorides as CL^- in excess of one (1) percent by weight shall not be used in prestressed concrete. If admixtures are used to entrain air, to reduce the water-cement ratio, to retard or accelerate setting time, or to accelerate the development of strength, they shall be used at the rate of dosage specified in the contract documents or as approved by the Engineer.

When the use of an air-entraining agent is specified, it shall be added in a quantity conforming to Table I of subsection 501.03.04, "Classifications and Proportions." It shall be measured accurately into each batch by equipment and methods approved by the Engineer. Adjustments shall be made in the weights of the aggregates used per batch to compensate for increased yield due to air-entrainment so that the quantities of cement per cubic yard of concrete remain constant. Such adjustments shall be made by decreasing the weight of fine aggregate without changing the weight of coarse aggregate unless otherwise approved by the Engineer.

Admixtures shall be measured accurately into each batch by methods approved by the Engineer.

Except as otherwise provided for air-entraining agents, samples of admixtures proposed for use shall be submitted by the Contractor to the Engineer in advance of intended use sufficiently to permit tests to be made to determine compliance with claimed properties.

Any type of admixture shall be uniform in properties throughout its use in the work. Should it be found that the admixture as furnished is not uniform in properties, its use shall be discontinued.

Admixtures shall be dispensed in liquid form. Dispensers for liquid admixtures shall have sufficient capacity to measure at one (1) time the full quantity required for each batch. Unless liquid admixtures are added to premeasured water for the batch, their discharge into the batch shall be arranged to flow

uniformly into the stream of water. Dosages of liquid admixtures shall not vary from the dosage approved by the Engineer by more than five (5) percent. Equipment for measurement shall be designed for convenient confirmation of the accuracy of measurement. If more than one (1) liquid admixture is used, each shall be dispensed by separate equipment unless otherwise permitted in writing by the Engineer.

When water-reducing agents or water-reducing retarders are used, the permitted dosage of the admixture shall not exceed that which will result in an increase in the drying shrinkage of the concrete in excess of twenty (20) percent when used in precast, prestressed concrete; ten (10) percent when used in cast-in-place prestressed concrete; ten (10) percent when used in cast-in-place reinforced concrete; or three (3) percent when used in non-reinforced concrete pavements.

Water reducers shall reduce the water demand of concrete for a given slump at least seven (7) percent when used at the maximum dosage recommended by the manufacturer. Set retarders shall not be used in greater dosages than those recommended by the manufacturer, nor more than that needed to obtain the desired retardation. The strength of the concrete containing the admixture in the amount approved by the Engineer shall, at the age of forty-eight (48) hours and longer, be not less than that of similar concrete without the admixture.

When the Contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit a certification stating that the admixture is the same as that previously approved. If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

Either prior to or at any time during construction, the Engineer may require that the admixture selected by the Contractor be further tested to determine its effect upon the strength of the concrete. When so tested, seven (7) day compressive strength of concrete made with the cement and aggregates in the proportions to be used in the work and containing the admixture under test shall not be less than eighty-eight (88) percent of the strength of concrete made with the same materials and with the same cement content and consistency but without the admixtures.

Subject to the following conditions, pozzolan conforming to subsection 702.03.08, "Pozzolans," may be used to replace up to fifteen (15) percent, by weight, of the required Portland cement in concrete.

Pozzolan shall not be permitted to replace Type III Portland cement or Type IP "blended" cement.

The replacement of cement with pozzolan shall be at a rate of one and two-tenths (1.2) pounds of pozzolan for each pound of Portland cement.

Pozzolan furnished for the project shall be stored in separate weathertight facilities.

501.02.04 Concrete Making Properties. Portland cement concrete shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Compressive Strength of Molded Concrete Cylinders	Nev. T475*	Table I (Page 270)
Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory	Nev. T455	.....
Making and Curing Concrete Compression Test Specimens in the Field	Nev. T428	.....
Unit Weight and Cement Factor, Fresh Concrete	Nev. T435	Table I (Page 270)
Air Content	Nev. T432 or Nev. T431	Table I (Page 270)
Method of Test for Specific Gravity and Absorption of Coarse Aggregate	Nev. T492	Min. saturated surface dry condition
Method of Test for Specific Gravity and Absorption of Fine Aggregate	Nev. T493	Min. saturated surface dry condition
Slump	Nev. T438 or Nev. T439**	Table I (Page 270)
Coring Concrete	Nev. T474	Subsection 502.04.01

*The compressive strength requirements of Portland cement concrete shall be based on the strength test, which is defined as the average of the breaking strength of three (3) standard cylinders at twenty-eight (28) days. The cylinder strengths shall be determined in accordance with Test Method No. Nev. T475.

**Unless otherwise required, Test Method No. Nev. T438 will be used.

A test, as defined above, will be required for each one hundred (100) cubic yards, or portion thereof, placed each day. There shall be at least one (1) strength test made each day that concrete is placed, regardless of the volume placed. Other cylinders may be made and broken for information purposes.

Statistical Evaluation of Concrete Strength. Portland cement concrete shall be proportioned, using the aggregates tested, such that the compressive strength requirements in Table 1 and the modifications included in these specifications, will be satisfied without falling below the minimum values given. Twenty-eight (28) day concrete strength will be used as the basis for acceptance. A strength test shall consist of the average strength of three (3) cylinders fabricated and tested in accordance with Test Method No. Nev. T475. Compressive strength tests made for acceptance will be evaluated by the moving average method. A moving average is defined as the numerical average of five (5) consecutive twenty-eight (28) day strength test results. The first individual test results shall start a moving average and shall meet the moving average strength requirements. Until five (5) test results are available, the moving average shall be the numerical average of the existing individual test results.

The minimum moving average strength required shall be the specified twenty-eight (28) day strength with no more than one (1) in ten (10) consecutive tests being allowed to fall below ninety-five (95) percent of the specified strength. Should concrete used in the work fail to conform to these requirements, the Contractor shall, at his expense, make corrective changes, subject to written approval by the Engineer, in the material mix proportions, in the concrete fabrication procedures, or take other corrective action, before placing additional concrete. In addition, such corrective changes shall also be

made when the compressive strength of concrete tested at seven (7) days indicates, in the judgment of the Engineer, that the concrete will not attain the required compressive strength of twenty-eight (28) days.

In addition to the aforementioned requirements, if any more than one (1) in ten (10) consecutive tests indicate a strength below ninety-five (95) percent of the specified strength, the concrete represented by all tests below ninety-five (95) percent of specified strength will be subject to the provisions in subsections 502.04.01 and 504.04.01, "Measurement." Any concrete represented by a single test, which indicates a strength of less than eighty-five (85) percent of the specified strength, shall be rejected or reviewed as provided in subsections 502.04.01 and 504.04.01, "Measurement."

Concrete specified by this standard is subject to prequalification of materials, mix proportions, mixing equipment, and procedures proposed for use, and prequalification will be required prior to placement of such concrete. Prequalification shall be accomplished by the Contractor's submission of acceptable certified test data or trial batch test reports. Prequalification data shall be based on the use of the same materials and mix proportions to be used in the work.

Certified test data, in order to be acceptable, must indicate that not less than ninety (90) percent of at least twenty (20) consecutive twenty-eight (28) day tests exceed the specified strength, and none of the tests are less than ninety-five (95) percent of specified strength. Fewer than twenty (20) consecutive twenty-eight (28) day tests may be submitted as certified test data, but acceptance will be subject to the evaluation and approval of the Engineer. In no case shall the number of tests be fewer than ten (10). Strength tests included in such data shall be the most recent tests made on concrete of the proposed mix design and all shall have been made within one (1) year prior to its proposed use on the contract for which the data is being submitted.

Trial batch test reports, in order to be acceptable, must indicate that the average compressive strength of five (5) standard six (6) inch by twelve (12) inch cylinders, taken from a single batch and tested at twenty-eight (28) days, shall be at least fifteen (15) percent greater than the specified twenty-eight (28) day compressive strength and no individual cylinder shall have a strength less than the specified strength. Upon special request, the prequalification requirements may be accomplished by substituting test data for concrete tested at seven (7) days and will be considered acceptable if, in the judgment of the Engineer, that concrete will attain the required compressive strength at twenty-eight (28) days. Data contained in the report shall be from a trial batch produced not later than thirty (30) days prior to its proposed use on the contract. Whenever air-entrainment is required, the air content of trial batches shall be within the range of the air content specified for the concrete. Trial batch test data shall be obtained from a qualified testing laboratory or from the same batch plant that will produce the concrete.

All tests for prequalification shall be performed in accordance with either the appropriate Nevada test method or the comparable ASTM test methods. All equipment employed in testing shall be in good condition and shall be properly calibrated. If the tests are performed during the life of this contract, the Engineer shall be notified sufficiently in advance of performing the tests so that he can witness the test procedures.

The certified test data or trial batch test reports shall include the following information:

(a) Date of mixing.

(b) Mixing equipment and procedures used.

(c) The size of batch in cubic yards and the weight, type, and source of all ingredients used.

(d) Slump of the concrete.

(e) The air content of the concrete if an air-entraining agent is used.

(f) The age at the time of testing and strength of all concrete cylinders tested.

All certified test data or trial batch test reports shall be signed by an official of the firm which performed the tests.

After materials, mix proportions, and procedures for concrete have been prequalified for use, additional prequalification by testing of trial batches will be required prior to making any changes which, in the judgment of the Engineer, could result in a lowering of the strength or durability of the concrete.

The Contractor's attention is directed to the time required to test trial batches and the Contractor shall be responsible for production of trial batches at a sufficiently early date so that the progress of the work is not delayed.

CONSTRUCTION

501.03.01 Equipment. Methods employed in performing the work, and all equipment, tools, and machinery used for handling materials and executing any part of the work, shall be subject to the approval of the Engineer. All equipment necessary shall be on hand and approved before concrete operations are begun by the Contractor.

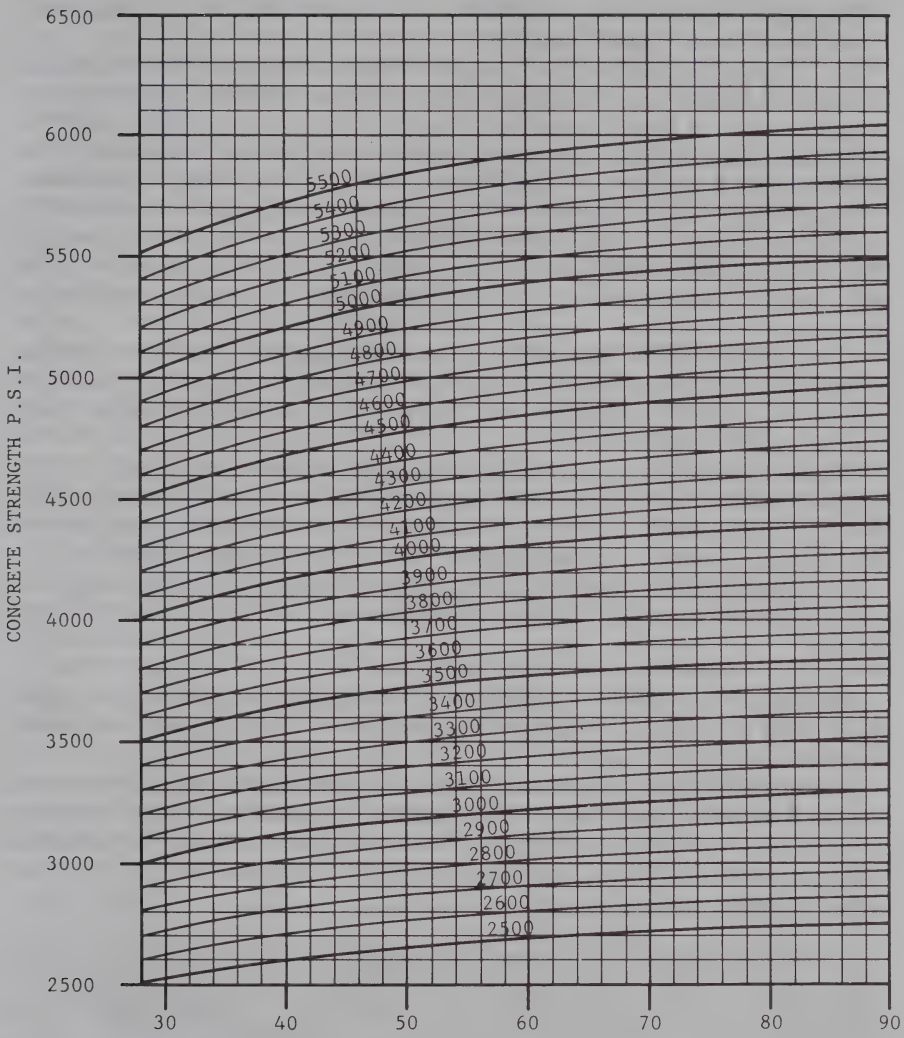
The Contractor shall maintain the equipment in good condition and adjustment. Concrete mixers and other equipment which are not adequate or suitable for the work shall be removed and suitable equipment shall be provided by the Contractor.

The Contractor shall provide adequate internal vibrating equipment, including power, to enable State forces to construct concrete cylinders for testing purposes. The internal vibrators shall conform to the following requirements:

Internal vibrators may have rigid or flexible shafts, preferably powered by electric motors. The frequency of vibration shall be seven thousand (7,000) vibrations per minute or greater while in use. The outside diameter or the side dimensions of the vibrating element shall be at least three-fourths (¾) inch and not greater than one and one-half (1½) inches. The length of the shaft shall be at least twenty-four (24) inches.

Vibrating equipment shall not be measured or paid for directly but the cost thereof shall be considered included in the contract unit price bid for other items of work and no further compensation shall be allowed therefor.

501.03.02 Protecting and Sampling Cement. Suitable means of storing and protecting the cement against moisture or other injurious effects shall be provided by the Contractor. Sacked or bulk cement which, for any reason, has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AGE, DAYS

CHART NO. 1

become partially set or which contains lumps of caked cement shall be rejected and shall be immediately removed from the work site.

Different brands of cement shall not be mixed during use or in storage, nor shall they be used alternately in any one (1) structure. The same brand and kind of cement shall be used in a given structure above the ground line.

The sacked cement shall be so piled as to permit access for tally, inspection, and identification of each shipment.

The Contractor shall obtain from the cement company from which the cement is purchased, a certificate stating that the cement delivered to the work complies with the specifications for the type of cement specified for use. The certificate shall be dated, signed, and indicate the quantity of shipment. Two (2) copies shall be delivered directly to the Engineer in charge of the work.

Upon receipt of the Certificate of Compliance, the Engineer may permit the use of the cement. When a Certificate of Compliance is not furnished the Engineer, the cement shall not be used in the work until a release for its use has been received by him from the Department's Materials and Testing Division.

When a Certificate of Compliance is not furnished, the Department shall be afforded sufficient time to make a seven (7) day test on approved brands of cement in common use, and a twenty-eight (28) day test on new or unapproved brands of cement.

Whenever it is determined by subsequent laboratory tests of mill or field samples that the cement does not comply with the specifications, subsequent use of cement from the same cement company will be delayed, if required by the laboratory, until tests can be made on each lot of cement delivered.

All cement not conforming to the specifications and all cement damaged by exposure to moisture shall be removed immediately and permanently from the work.

501.03.03 Storage of Aggregates. The handling and storage of aggregates shall be such as to prevent segregation or contamination by foreign materials.

In placing materials in storage or in moving them from storage to the mixer, any method which may cause the segregation, degradation, or the combining of material of different gradings which will result in any stockpile or bunker failing to meet specified requirements shall be discontinued and the materials shall be reprocessed or wasted.

501.03.04 Classifications and Proportions. The Contractor shall notify the Engineer not less than thirty-two (32) calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes.

When requested by the Contractor, exceptions to the above requirement may be granted in writing by the Engineer under either of the following conditions:

(a) The concrete structures on the project are minor in nature, such as culvert headwalls, manholes, small boxes, sidewalks, etc., generally, when less than one hundred (100) cubic yards of concrete are called for on the project.

(b) when the aggregate source has been previously tested within the past one (1) year and accepted by the State.

Samples will not exceed five hundred (500) pounds for each separate grading. The Contractor shall furnish a written statement giving the cement factor in sacks per cubic yard, the proportions of cement, water, and each size of aggregate by weight in a saturated surface dry condition, and the percentage of air in the concrete proposed for use in the work. If the Contractor proposes to use an admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement.

Portland cement concrete shall be proportioned, using the aggregates tested, such that the compressive strength requirements in Table I will be satisfied without falling below the minimum, or exceeding the maximum values given. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions, except in the case of Class EA concrete where no changes will be allowed without new laboratory trial testing in accordance with these specifications.

Batches of concrete shall not vary more than plus or minus three (3) pounds per cubic foot in unit weight from design mix. The cement factor of any individual batch placed in the work shall not be more than fifteen one-hundredths (0.15) sack per cubic yard less, nor more than twenty-five one-hundredths (0.25) sack per cubic yard greater than the designated factor (sacks of cement per cubic yard). Aggregates shall be batched and reported to the Engineer. The weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

When "Class EA Concrete, Modified (Major)" is designated for use in specific portions of structures, the following requirements shall apply to said Class EA concrete:

Laboratory trial tests shall be required to determine strength and compatibility of all materials (as specified in Table I of this subsection and in subsection 501.02.03 of these specifications) to be used. Tests performed must be made by a laboratory approved by the Department and the Contractor shall furnish documentation of such tests. Laboratory trial batches may be observed by the Engineer. All costs of laboratory trial testing will be at the Contractor's expense.

501.03.05 Proportioning Methods. Except as hereinafter noted, aggregate bins shall conform to either (a) or (b) as follows:

(a) Each specified size of aggregate shall be stored in a separate bin. Except as hereinafter specified, each bin shall be provided with an individual outlet gate, designed and constructed to prevent leakage when closed. The gates shall cut off quickly and completely.

(b) Each size aggregate shall be weighed individually in a single bin, providing there is a satisfactory method employed to eliminate any excess material resulting from over-charging of the bin before the material reaches the surge hopper.

(a) and (b) above will not be required when batching for culvert headwalls, manholes, small boxes, sidewalks, etc., and the total quantity of Class A,

TABLE I

Class of Concrete	Cem. Range, Sacks per Cu. Yd.	Coarse Agg. Size No.	Max. Water Gal. Per Sack Cement*	Min. Compr. Str. (28 day) p.s.i.**	Slump Range, Inches Nev. T438	Air Range, Per-cent	Unit Weight Varia-tions	Use
A	6.0–7.5	467	6	3,000	1–4	.....	±3 lbs.	General use and reinforced structures
AA	6.0–7.5	467	6	3,000	1–4	4–7	±3 lbs.	
B	5.5–7.5	357	6	3,000	1–5	.....	±3 lbs.	Massive or lightly reinforced sections
BA	5.5–7.5	357	6	3,000	1–4	4–7	±3 lbs.	
C	5.0–6.5	357	6.75	2,500	1–5	.....	±3 lbs.	Massive unreinforced and backfill
CA	5.5–7.0	357	5.75	2,500	1–5	4–7	±3 lbs.	
D	6.0–7.5	67	6	3,000	1–4	.....	±3 lbs.	Thin reinforced sections, handrails, etc.
DA	6.0–8.0	67	6	3,000	1–4	4–7	±3 lbs.	
PAA	6.0–8.0	67	6	Specified on Plans	0–4	Specified on Plans	±3 lbs.	Prestressed members
Modified A and AA	6.0–8.0	467	6	Specified on Plans	1–4	4–7 (AA only)	±3 lbs.	Where specified on plans
Modified D and DA	6.0–8.0	67	6	Specified on Plans	1–4	4–7 (DA only)	±3 lbs.	
Modified EA	6.5–8.0	57	5	Specified on Plans	1–2.5	5–7	±3 lbs.	Roadway deck slabs, slab spans of bridges, approach slabs, and barrier rail.

*Based on aggregate in a saturated surface dry condition.

**Attention is directed to subsection 501.02.04 of these specifications for the moving average method of evaluating concrete.

AA, D, or DA concrete called for on the project does not exceed three hundred (300) cubic yards.

All aggregates for use in Portland cement concrete shall be proportioned by weight, with the exception that aggregates for culvert headwalls, short pieces of curbs and gutter, or small sections of sidewalk and related minor work may be proportioned either by weight or volume as the Contractor may elect. Measuring boxes of known capacity shall be furnished and used to measure each size of aggregate proportioned by volume.

Batches requiring fractional sacks of cement will not be permitted, unless the Contractor elects to weigh the cement in each batch.

Bulk cement shall be weighed separately when the batch is one (1) cubic yard or more. The scale and weigh hopper for the cement shall be separate and distinct from the aggregate hopper or hoppers. The discharge mechanism of the bulk cement hopper shall be interlocked against opening before the full amount of cement is in the hopper, against closing before the contents of the hopper are entirely discharged and the scales are back in balance, and against opening when the amount of cement in the hopper is underweight by more than one (1) percent of the amount specified. An interlock system will not be required on projects having less than three hundred (300) cubic yards in the bid schedule.

Scales utilized in the proportioning device may be of the springless dial type or of the multiple beam type.

If of the dial type, the dial shall be of such size and so arranged that it may be read easily from the operating platform.

If of the multiple beam type, the scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over or underweight. The indicator shall be so designed that it will operate during the addition of the last four hundred (400) pounds of any weighing. The over travel of the indicator hand shall be at least one-third (1/3) of the loading travel. The indicator shall be enclosed against moisture and dust.

Weighing equipment shall be insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading and cutoff shall not vary from the weight designated by more than one (1) percent for cement and one and one-half (1 1/2) percent for any size of aggregate, nor one (1) percent for the total aggregate in any batch.

Scales shall be approved with a Certificate of Inspection as required in subsection 109.01, "Measurement of Quantities."

Should separate supplies of aggregate and material of the same size group, but of different moisture content or specific gravity be available at the proportioning plant, withdrawals shall be made from one (1) supply exclusively and the material therein completely exhausted before starting upon another.

Stockpiled aggregates shall be in a saturated surface dry condition just prior to batching. The moisture content of the aggregate shall be such that no visible separation of moisture and aggregate will take place during transportation from the proportioning plant to the point of mixing. Aggregate containing excess moisture shall be stockpiled prior to use until sufficiently dried to meet the above requirements.

Batches with cement in contact with damp aggregates shall be mixed within

thirty (30) minutes after being proportioned. Batch trucks hauling more than one (1) batch of cement and aggregate shall be so constructed that materials do not flow from one (1) compartment to another during haul or discharge.

Coarse and fine aggregate shall be handled and measured separately. Each bag of cement shall contain ninety-four (94) pounds net and shall be emptied directly into charging skip of the mixer. Water shall be measured either by volume or by weight.

The equipment for measuring and supplying the water to the mixer shall be so constructed and arranged that the amount of water added to the mixture can be measured positively and that the predetermined quantity of water required can be discharged rapidly in one (1) operation into the mixing drum without dribbling. The equipment shall be so designed that water from the source of supply cannot enter the measuring tank while the water is being discharged from the measuring tank into the mixer. Tanks or other equipment for measuring and discharging water into the mixer shall be sufficiently accurate that the amount of water delivered to the mixer for any batch shall not vary more than one (1) percent from the required quantity of water for any position of the mixer with respect to level plane. The tanks or other equipment shall be so arranged as to permit the checking of the amount of water delivered by discharging into measured containers.

501.03.06 Machine Mixing. (a) General. All concrete shall be mixed in mechanically operated mixers, except that when permitted by the Engineer, batches not exceeding one-third (1/3) cubic yard may be mixed by hand methods in accordance with the provisions of subsection 501.03.07, "Hand Mixing." Mixers shall have legible permanently attached plates showing manufacturer's rated capacity, mixing speeds, and serial number.

Mixers may be stationary mixers or truck mixers. Agitators may be truck mixers operating at agitating speed or truck agitators. Each mixer and agitator shall have attached thereto in a prominent place a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the manufacturer's guaranteed capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades.

The Contractor, at his expense, shall furnish samples of the fresh concrete and provide safe and satisfactory facilities for obtaining the samples.

Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer.

The temperature of materials as charged into the mixer shall be such that the temperature of the mixed concrete at the time it is placed in final position is not less than fifty (50) degrees Fahrenheit nor more than ninety (90) degrees Fahrenheit as specified in subsection 501.03.10(b). Aggregates and water used for mixing shall not exceed one hundred fifty (150) degrees Fahrenheit.

Concrete for structures shall be mixed for a period of not less than sixty (60) seconds nor more than five (5) minutes after all materials, including water, are in the mixer.

Cement shall be batched and charged into the mixer by means that will not result either in loss of cement due to the effect of wind, or in accumulation of

cement on surfaces of conveyors or hoppers, or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

Stationary mixers having a capacity of one (1) cubic yard or more and all paving mixers shall be operated with an automatic timing device that can be locked by the Engineer. The time device and discharge mechanisms shall be so interlocked that during normal operations no part of the batch will be discharged until the specified mixing time has elapsed.

The total elapsed time between the intermingling of damp aggregates and cement and the start of mixing shall not exceed thirty (30) minutes.

Mixers and agitators which have an accumulation of hard concrete or mortar or worn blades shall not be used.

When central-mixed concrete is furnished and non-agitating hauling equipment is used for transporting concrete to the delivery point, for Portland cement concrete pavement, discharge into the laydown machine shall be completed within forty-five (45) minutes after the addition of the cement to the aggregates.

(b) On-Site Mixed Concrete. When mixing at the site of the work the mixers used shall be of the paving or stationary type. The size of batch shall not exceed the rated capacity as determined by the standard requirements of the Associated General Contractors of America, except that in paving mixers when used for Portland cement concrete pavement, concrete slope protection and curbs and sidewalks, the size of batch may exceed the rated capacity of the mixer as determined by the standard requirements of the Associated General Contractors of America to a total of thirty-two and four-tenths (32.4) cubic feet in 27E mixers and forty and eight-tenths (40.8) cubic feet in 34E mixers, provided that all parts of the mixer will hold the overcharge without spillage, that the uniformity and strength of the resulting concrete is not reduced, and provided further that when paving mixers are operating on grades in excess of six (6) percent, the size of batch shall not exceed twenty-nine and seven-tenths (29.7) cubic feet in 27E mixers nor thirty-seven and four-tenths (37.4) cubic feet in 34E mixers.

(c) Ready-Mixed Concrete. Ready-mixed concrete shall include central-mixed, shrink-mixed, and transit-mixed concrete. Shrink-mixed concrete is that which has been mixed partially in a stationary mixer and the mixing completed in a truck mixer.

The size of batch in truck mixers and truck agitators shall not exceed the rated capacity as determined by the current standard requirements of Truck Mixer Manufacturers Bureau. The size of batch in stationary mixers shall not exceed the rated capacity of the mixer as determined by the standard requirements of the Associated General Contractors of America. No batches requiring fractional sacks of cement will be permitted unless all of the cement is weighed when added to the batch.

If the use of ready-mixed concrete is approved, the producer shall use only that cement approved by the State for use on the project. State-approved cement shall be stored at the concrete plant in such a manner that it can be identified and kept separate from other cement.

Ready-mixed concrete for structures shall be transported in truck mixers or truck agitators.

The mixer, when loaded to capacity, shall be capable of combining the

ingredients of the concrete within the specified time, into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity. The agitator, when loaded to capacity, shall be capable of maintaining the mixed concrete in a thoroughly mixed uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

Mixers and agitators shall be examined periodically for changes in condition due to accumulation of hardened concrete or mortar or to wear of the blades. When any such change of condition is found, the concrete should be subjected to the slump tests. If the tests indicate that the concrete is not being properly mixed, the faulty equipment shall be corrected before its further use is allowed.

Truck mixers shall be equipped with electrically or mechanically actuated revolution counters by which the number of revolutions of the drum or blades may be readily verified. The counters shall be of the continuous-registering, non-resettable type, which accurately register the number of revolutions, and shall be mounted on the truck mixer so that the Engineer may safely and conveniently inspect them from alongside the truck.

When a truck mixer is used, each batch of concrete shall be mixed for not less than seventy (70) nor more than one hundred (100) revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If any additional mixing is done, it shall be at the speed designated by the manufacturer of the equipment as agitating speed.

When shrink-mixed concrete is furnished, concrete that has been partially mixed at a central plant shall be transferred to a truck mixer and all requirements for transit-mixed concrete shall apply. No credit in the number of revolutions at mixing speed shall be allowed for partial mixing in a central plant.

No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point, unless permitted by the Engineer. If the Engineer permits additional water to be incorporated into the concrete, the drum shall be revolved not less than thirty (30) revolutions at mixing speed after the water is added and before discharge is commenced.

The rate of discharge of mixed concrete from truck mixer-agitators shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

When truck mixer or truck agitator is used for transporting concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within ninety (90) minutes after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete as determined by the Engineer, a delivery time of less than ninety (90) minutes may be required. When a truck mixer is used for the complete mixing of the concrete the mixing operations shall begin within thirty (30) minutes after the cement has been intermingled with the aggregate.

If the mixing plant is such a distance from the site of the work that is not practical to have the mixed concrete delivered and placed in forms within the time limit specified, cement and water shall not be added until such time requirement can be complied with.

The organization supplying concrete shall have sufficient plant capacity and transporting apparatus to insure continuous delivery at the rate required. The rate of delivery of concrete shall be such as to provide for the proper handling and placing of concrete. An interval of more than forty-five (45) minutes between any two (2) consecutive batches or loads, a delivery and placing rate of less than eight (8) cubic yards of concrete per hour on work other than new bridge decks, or a delivery and placing rate of less than twenty (20) linear feet per hour of new concrete bridge decks, shall constitute cause for shutting down work for the remainder of the day, and if so ordered by the Engineer, the Contractor shall make, at his own expense, a construction joint at the location and of the type directed by the Engineer in the concrete already placed.

After mixing of ready-mixed concrete has been completed it shall be agitated continuously at agitating speed until it has been discharged from the drum.

Concrete manufactured by any procedure which results in any unmixed lumps of cement in the mixed product shall be rejected.

A ticket system shall be used for recording the transportation and delivery of batches from the plant to the site of the work. The tickets will be issued by a State inspector to the truck operator at the plant for each load. The tickets shall be delivered to the inspector at the site of the work. Loads which do not carry such tickets or which do not arrive in satisfactory condition shall not be used in the work.

501.03.07 Hand Mixing. Hand mixing shall not be permitted, except in case of an emergency or under written permission of the Engineer. When permitted, it shall be done only on watertight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of uniform color, after which it shall be formed into a "crater" and water added in the amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and returned at least six (6) times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand mixing will not be permitted for concrete to be placed under water.

501.03.08 Retempering. Concrete shall be mixed only in such quantities as are required for immediate use and shall be placed before initial set has taken place. Any concrete in which initial set has begun shall be wasted and not used in the work. No retempering of concrete shall be allowed.

501.03.09 Curing. (a) General. All concrete shall be cured for the

length of time hereinafter specified. If Type III cement is used, the curing time may be reduced as directed by the Engineer. In the event of low temperatures, the time will be increased according to the procedure specified in subsection 501.03.10(b), "Cold Weather."

Curing shall commence immediately upon completion of the finish. In the event that the application or placement of the curing medium is delayed, curing will be as described under (b) below.

(b) Water Method. The concrete shall be kept continuously wet by the application of water for a minimum period of seven (7) days after the concrete has been placed.

Fogging equipment shall be capable of applying water in the form of a fine mist, not a spray. It may be water pumped under adequate high pressure, or a combination of air and water pumped under high pressure; either system in combination with a suitable atomizing nozzle. The equipment shall be sufficiently portable for use in the direction of any prevailing wind. It shall be adaptable for intermittent use as directed by the Engineer to prevent excessive wetting of the concrete.

Cotton mats, rugs, carpets, or earth or sand blankets may be used as a curing medium to retain the moisture during the curing period. The cotton mats, rugs, or carpets shall be of such character that they will retain water.

(c) Curing Compound Method. From the time of initial strike off of the concrete until finishing is completed and required curing is in place, the unformed surfaces of slab concrete in bridge decks and exposed slabs of culverts shall be fogged as specified in (b) above when necessary to replace water loss due to evaporation.

The entire surface of the concrete shall be sprayed uniformly with a curing compound conforming to the requirements of subsection 702.03.01, "Curing Materials." Unless otherwise specified, the curing compound shall be applied to the exposed surface at a uniform minimal rate of one (1) gallon per one hundred fifty (150) square feet of area. It shall be applied when a light film of water is present on the surface. If the surface is dry, water shall be added as specified in subparagraph (b) "Water Method" before the curing compound is applied.

On surfaces cured by this method, foot traffic must be held to a minimum and these surfaces shall not be used as a work area during the cure period. Should the film of the compound be damaged before the expiration of seven (7) days, the damaged portions shall be repaired immediately with additional compound.

The curing compound shall not be applied until all patching and surface finishing, except grinding, has been completed. When deemed necessary by the Engineer, during periods of hot weather, fogging of the concrete with water shall be continued after curing compound is applied until the Engineer determines that a cooling effect is no longer required. Such fogging after the application of the curing compound will be paid for as extra work as provided in subsection 104.03, "Extra Work."

The curing compound shall be delivered to the work in ready-mixed form. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. The compound

shall not be diluted or altered in any manner after manufacture, unless dilution is recommended by the manufacturer.

All curing compounds shall remain sprayable at temperatures above forty (40) degrees F. and shall not hard settle in storage.

Curing compound that has become chilled to such an extent that it is too viscous for satisfactory application shall be warmed to a temperature not exceeding one hundred (100) degrees Fahrenheit.

The curing compound shall be packaged in clean fifty-five (55) gallon steel barrels or round five (5) gallon steel containers or shall be supplied from a suitable storage tank located at the jobsite. Each fifty-five (55) gallon barrel shall be equipped with a built-in agitator having two (2) sets of blades; one at the bottom, and the second, midway between top and bottom of container, and shall have removable lids and airtight band fasteners. On-site storage tanks shall be kept clean and free of all contaminants. Each tank shall have a permanent system designed to completely redisperse any settled material without introducing air or any other foreign substance. Barrels shall be filled in a manner that will prevent skinning. Five (5) gallon containers shall be well sealed with ring seals and lug type crimp lids. The lining of the containers shall be of a character that will resist the solvent of the curing compound and will not permit skins to be loosened into the body of the curing compound. Each container shall be labeled with the manufacturer's name, batch number, type of compound, number of gallons, and date of manufacture, and shall have an Interstate Commerce Commission Red Label warning concerning flammability. The label shall also warn that the curing compound shall be well stirred before use. When the curing compound is shipped in tanks or tank trucks, a shipping invoice shall accompany each load. The invoice shall contain the same information as that required herein for container labels.

Curing compound may be sampled by the Engineer at the source of supply or at the jobsite or at both locations.

If the compound has not been used within one hundred twenty (120) days after the date of manufacture, the Engineer may require additional testing before use, to determine compliance to requirements.

Portland cement concrete bridge decks that are to be the roadway surfaces shall be cured with a white pigmented curing compound—chlorinated rubber base conforming to the requirements of Section 702. The area to be treated shall be the top surface of concrete bridge decks except that care shall be exercised to keep the compound off all parapets or other surfaces which are to receive a "Fine Surface Finish ('FSF')" as specified on the plans.

The average minimal rate of application of the chlorinated rubber base type, at any point, shall be one (1) gallon per two hundred fifty (250) plus or minus fifty (50) square feet. Power operated spraying equipment for application of curing compound shall be equipped with an operational pressure gage and means of controlling the pressure.

The curing compound shall be applied to the top surface of concrete bridge decks following the surface finishing operation immediately after the moisture sheen begins to disappear from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any delay in the application of curing compound, which could result in any drying or cracking of the surface,

application of water with an atomizing nozzle as specified in subsection 501.03.09(b), "Water Method," of these specifications, shall be started immediately and shall be continued until application of the compound is resumed or started; however, the compound shall not be applied over any resulting free standing water. Should the film of compound be damaged from any cause before the expiration of seven (7) days after the concrete is placed, the damaged portion shall be repaired immediately with additional compound.

(d) Waterproof Membrane Method. The exposed finished surfaces of concrete shall be kept damp with water using a nozzle that so atomizes the flow that a mist and not a spray is formed, until the concrete has set, after which the curing membrane shall be placed. The membrane shall be formed into sheets of such width as to provide a complete cover of the entire concrete surface. All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint. Overlap of sheets shall have a minimum lap of eighteen (18) inches. The sheets shall be securely weighted down by placing a bank of earth on the edges of the sheets or by other means satisfactory to the Engineer.

Sheeting material shall conform to the requirements of subsection 702.03.01, "Curing Materials."

The curing membrane shall remain in place for a period of not less than seven (7) days.

Should any portion of the sheets be broken or damaged before the expiration of the curing period, the broken or damaged portion shall be immediately repaired with new sheets properly cemented into place, or water curing as described above shall commence immediately. Sections of the membrane shall not be used which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing.

(e) Form Method. If forms are kept on concrete surfaces, this will be considered adequate cure for these surfaces. However, should the forms be removed within seven (7) days after the concrete has been placed, one (1) of the above methods must be used on the exposed surfaces.

Attention is directed to subsection 502.03.12, "Removal of Falsework, Forms, and Housing."

501.03.10 Weather Limitations. (a) General. If impending inclement weather conditions exist, the Contractor shall decide whether or not to begin the pour and he shall have sole responsibility for his decision. Before any concrete is placed, the Contractor shall have adequate provisions readily available, as approved by the Engineer, to protect the concrete from any impending weather conditions. In case precipitation should occur after placing operations have started, the Contractor shall provide ample covering to protect the work. The placing of concrete shall be stopped before the quantity of precipitation is sufficient to cause a flow or to wash the surface.

(b) Cold Weather—General. All concrete shall be maintained at a temperature of not less than fifty (50) degrees Fahrenheit for three (3) days or not less than forty (40) degrees Fahrenheit for seven (7) days. The count of time shall commence immediately upon completion of final placement and vibration. The three (3) fifty (50) degree days need not be consecutive.

One (1) twenty-four (24) hour period shall constitute one (1) day.

The temperature of the concrete shall be determined by placement of thermometers on the concrete surfaces and properly insulating said devices to record the surface temperature of the concrete in accordance with Test Method No. Nev. T440. Temperature shall be monitored continuously throughout the total protection time required by this subsection. In case the surface temperature of the concrete falls below forty (40) degrees Fahrenheit for a duration of three (3) hours or more in any twenty-four (24) hour period during the time of temperature protection, the time shall be increased one (1) day for each day this occurs. An absolute minimum temperature of thirty-five (35) degrees Fahrenheit must be maintained for the total time of protection specified in this subsection. Should the temperature of the concrete fall below thirty-five (35) degrees Fahrenheit at any time, damage may occur. The assessment of damage will be determined by the Department and concrete so damaged may require repair or replacement at the option of the Engineer.

The concrete shall have a temperature of at least fifty (50) degrees Fahrenheit and not more than ninety (90) degrees Fahrenheit at the time of placing. (See also subsection 501.03.06, "Machine Mixing.") Heating equipment or methods which alter or prevent the entrainment of the required amount of air in the concrete shall not be used. The equipment shall be capable of heating the materials uniformly. Aggregates and water used for mixing shall not be heated to a temperature exceeding one hundred fifty (150) degrees Fahrenheit. Concrete containing frost or lumps at the time of placing shall not be used.

Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire. The use of live steam on or through binned aggregates will not be permitted.

Reinforcing steel shall be free of ice, snow, or frost during placement of concrete. Concrete shall not be placed on frozen ground.

(c) Low Temperature Protection.

1. General. After the concrete has been placed, means shall be taken to protect the concrete from any impending low temperatures. Methods and materials not hereinafter prescribed may be used if approved by the Engineer and the following requirements adhered to:

a. Materials shall be fire resistant;

b. Materials shall be waterproof; and

c. Materials shall not adhere, abraid, or damage the surface of the concrete.

Approval of the Engineer shall not relieve the Contractor from obtaining specification results.

2. Insulating Blankets. Insulating blankets used to protect concrete from low temperatures shall be fire resistant and waterproof. The blankets must be secured and overlapped along the edges and joints to insure that no opening will exist in the protection due to high winds or other adverse conditions. Provisions shall be made to allow the reading of any thermometers placed inside of the protection. When depositing concrete against previously cast concrete, the blanket insulation shall extend at least fourteen (14) inches onto the existing concrete and securely held in place.

3. Low Temperature Protection—Heating and Housing. In order to meet the provisions of articles (a) and (b) of this subsection, the concrete may be protected by applying artificial heat within an enclosure. The enclosure will be constructed with fire resistant material, unless otherwise directed by the Engineer, and shall be subject to his approval. The heating system shall be so arranged as to provide uniform heating, insuring that the concrete farthest from the source of heat is receiving adequate protection without drying the concrete near the source of heat so as to cause shrinkage cracks.

(d) Hot Weather. The maximum temperature of cast-in-place concrete shall not exceed ninety (90) degrees Fahrenheit immediately before placement.

For continuous placement on the deck on continuous steel units, the initial set of the concrete shall be retarded sufficiently to insure that it remains plastic in not less than the span immediately preceding the one being placed.

For both simple and continuous spans, a retardation schedule shall be submitted by the Contractor and approved by the Engineer.

The consistency of the concrete as placed should allow the completion of initial finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for initial finishing, the required water shall be applied to the surface by fog spray only, and shall be held to a minimum amount. Fog spray for this purpose shall be applied as specified in subsection 501.03.09(b), "Water Method."

From the time of initial strike-off until final finish is complete, the unformed surfaces of slab concrete shall be protected from rapid evaporation of mixing water from the concrete due to wind, high temperature, low humidity, or combinations thereof.

Equipment for fogging, type of evaporation retarder, and method of application shall be approved by the Engineer. Equipment shall be portable adapted for intermittent use and operable in the direction of any prevailing wind.

BASIS OF PAYMENT

501.05.01 Payment. Portland cement concrete will be measured and paid for in accordance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

SECTION 502

CONCRETE STRUCTURES

DESCRIPTION

502.01.01 General. This work shall consist of furnishing and placing Portland cement concrete in bridges, culverts, headwalls, retaining walls, barrier rail, and all other types of concrete structures. The concrete structures shall be constructed to the lines and grades given by the Engineer and in accordance with the design shown on the plans; the concrete shall be of the class or classes of concrete designated in the proposal and on the plans and shall conform to the requirements of Section 501, "Portland Cement Concrete." Unless otherwise specified, Class A or Class AA concrete shall be used; however, the Contractor may at his option substitute Class D for Class A concrete or Class DA for Class AA concrete.

MATERIALS

502.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the requirements for such materials in the following sections:

Portland Cement Concrete	Section 501
Concrete Curing Materials and Admixtures	Section 702
Joint Materials	Section 707
Reinforcement	Section 713
Miscellaneous Metals	Section 712
Elastomeric Bearing Pads	Section 725
Concrete Surface Finishing Material	Section 727

CONSTRUCTION

502.03.01 Depth of Footings. The elevation of the bottoms of footings, as shown on the plans, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

502.03.02 Forms. All forms shall be built mortar tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused. Before concrete is poured in forms all inside surfaces of the forms shall be thoroughly coated with an approved coating or form oil. Coating or form oil shall leave no film on the surface of the form that can be absorbed by the concrete. When required by the Engineer and immediately before placing concrete, the forms shall be thoroughly wetted with water.

When requested by the Engineer, the Contractor shall submit detailed plans of form work for examination by the Engineer. If such plans are not satisfactory to the Engineer, the Contractor shall make such changes as may be required, but it is understood that the Engineer's concurrence in the use of the

plans as submitted or corrected shall in no way relieve the Contractor of responsibility in obtaining satisfactory results.

The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration on the concrete as it is placed.

Forms shall be filleted at all exposed corners unless corners are rounded as hereinafter provided. Triangular molding used for fillets shall have two (2) equal sides. In general, the width of the equal sides of moldings shall be three-fourths (3/4) inch; for massive work, such as heavy pier copings and columns, the width shall be one and one-half (1 1/2) to two (2) inches. Top edges of walls may be filleted or rounded as hereinafter provided for curbs. Top edges of curbs and slabs shall be rounded with an edging tool to a radius of one-half (1/2) to three-fourths (3/4) inch.

When concrete is placed in excavation, forms shall be provided for all vertical surfaces unless otherwise permitted by the Engineer. Ports shall be provided in high, thin walls to permit thorough cleaning before placing concrete.

If the forms develop any defects, such as bulging or sagging, after the concrete has been poured, that portion of the work shall be corrected in a manner satisfactory to the Engineer, without additional compensation to the Contractor.

During the erection and after the completion of the forms, they shall be protected in such manner as to preclude shrinkage, warping, curling, and distortion. Form lumber used a second time shall be free from bulge or warp and shall be thoroughly cleaned.

Forms for concrete over or in the vicinity of operating railroads shall be so constructed and placed that standard clearances demanded by the railroad company will be maintained at all times.

The falsework and forms supporting the bottom slab of the superstructure of box girder structures shall remain in place until the curing period of the deck of the superstructure has expired. Unless otherwise permitted by the Engineer, forms for the webs of box girders shall be removed before the deck slab is poured. All interior forms in box girders, except those permitted to remain in place, shall be completely removed and the inside of the box girder cleared of all loose material and swept clean.

Side forms for beams, girders, columns, railing, or other members of the structure wherein the forms do not resist dead load bending may be removed as specified in subsection 502.03.12(c).

The side forms for arch rings, columns, and piers shall be removed before the members of the structure which they support are poured or placed, so that the quality of the concrete may be inspected. All such side forms shall be so constructed that they may be removed without disturbing other forms which resist direct load or bending stresses.

The condition of the forms will have a direct bearing upon the amount of finishing required.

Full pieces of forms shall be used and shall extend from the bottom to the top of the wall or post.

Curved surfaces shall be formed to provide a smooth surface without visible breaks.

The forms shall be so constructed that portions, where finishing is required, may be removed without disturbing portions of forms to remain.

Forms shall be of sufficient strength to carry the dead weight of the concrete as a liquid without a deflection in excess of $\frac{L,}{270}$ and if such deflection occurs, it shall be sufficient cause for rejection of the work.

Forms for girders and slabs shall be cambered in such amounts as may be required by the Engineer.

Approved form clamps or bolts shall be used to fasten forms. The use of ties consisting of twisted wire loops to hold forms in position during the placing of concrete will not be permitted.

Bolts or form clamps shall be positive in action and shall be of sufficient strength and number to prevent spreading of the forms. They shall be of such type that they can be entirely removed or cut back sufficiently to allow finishing of the concrete.

Plywood for forms shall be "exterior type" of the grade concrete-form exterior, conforming to the specifications of the U.S. Department of Transportation, National Bureau of Standards, Commercial Standards, latest edition. Plywood form panels shall be furnished and placed in four (4) foot widths and in uniform lengths of not less than eight (8) feet, except where the dimensions of the member form are less than the specified panel dimensions. Where form panels are attached directly to the studding or joints, the panel shall not be less than five-eighths (5/8) inch thick. Form panels less than five-eighths (5/8) inch thick, otherwise conforming to the requirement herein specified, may be used with continuous backing of one (1) inch nominal thickness surfaced material. All form panels shall be placed in a neat symmetrical pattern subject to the approval of the Engineer. The panel shall be placed with the long dimension perpendicular to the studs.

Plywood for left-in-place forms in box girders may be of any grade and thickness that will satisfy the other requirements of this subsection.

Fabricated stay-in-place metal forms may be used for concrete floor slabs at the Contractor's option when so noted on the plans.

Metal forms to remain in place for concrete floor slabs shall be fabricated from steel conforming to ASTM Designation A446 (Grade A through E) having a coating class of G165 according to ASTM Designation A525.

The following criteria shall govern the design of permanent stay-in-place steel bridge deck forms.

The steel forms shall be designed on the basis of dead load of form, reinforcement and plastic concrete plus fifty (50) pounds per square foot for construction loads. The unit working stress in the steel sheet shall be not more than seven hundred twenty-five one-thousandths (0.725) of the specified minimum yield strength of the material furnished, but not to exceed thirty-six thousand (36,000) pounds per square inch.

Deflection due to the sum of the weight of the forms, the plastic concrete, and the reinforcement shall not exceed one-half (1/2) inch. The dead load used to compute the deflection shall in no case be less than one hundred twenty (120) pounds per square foot total.

The permissible form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.

The design span of the form sheets shall be the clear span of the form plus two (2) inches measured parallel to the form flutes.

Physical design properties shall be computed in accordance with requirements of the American Iron and Steel Institute Specification for the Design of Cold Formed Steel Structural Members, latest published edition.

All reinforcement shall have minimum concrete cover of one (1) inch.

The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.

Permanent steel bridge deck form shall not be considered as lateral bracing for compression flanges of supporting structural members.

Permanent steel bridge deck form shall not be used in panels where longitudinal deck construction joints are located between stringers.

Welding shall not be permitted to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel.

Fabricator shop and erection drawings shall be submitted to the Engineer for approval. These plans shall indicate the grade of steel the physical and section properties for all permanent steel bridge deck form sheets and a clear indication of locations where the forms are supported by steel beam flanges subject to tensile stresses.

All forms shall be installed in accordance with detailed fabrication and erection plans submitted to the Engineer for approval. The fabrication plans shall clearly indicate locations where the forms are supported by steel beam flanges subject to tensile stresses.

Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of one (1) inch at each end. Form supports shall be placed in direct contact with the flange of stringer or floor beam. All attachments shall be made by permissible welds, bolts, clips, or other approved means. However, welding of form supports to flanges of steels not considered weldable and to portions of flange subject to tensile stresses shall not be permitted. Welding and welds shall be in accordance with the provisions of AWS D1.1 pertaining to fillet welds except that one-eighth (1/8) inch fillet welds will be permitted.

Any permanently exposed form metal where the galvanized coating has been damaged shall be thoroughly cleaned, wire brushed and painted with two (2) coats of zinc oxide-zinc dust primer, Federal Specification TT–P–641, Type II, no color added, to the satisfaction of the Engineer. Minor heat discoloration in areas of welds need not be touched up.

Transverse construction joints shall be located at the bottom of a flute and one-fourth (1/4) inch weep holes shall be field drilled at not more than twelve (12) inches on center along the line of the joint.

Particular emphasis shall be placed on proper vibration of the concrete to avoid honeycomb and voids, especially at construction joints, expansion joints, and valleys and ends of form sheets. Pouring sequences, procedures, and mixes shall be approved by the Engineer. Calcium chloride or any other

admixture containing chloride salts shall not be used in the concrete placed on permanent steel bridge deck forms.

The Contractor's method of construction shall be carefully observed during all phases of the construction of the bridge deck slab. These phases include installation of the metal forms; location and fastening of the reinforcement; composition of concrete items; mixing procedures, concrete placement, and vibration; and finishing of the bridge deck. Should the Engineer determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, the Contractor shall remove at least one (1) section of the forms at a location and time selected by the Engineer for each span in the contract. This should be done as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the Contractor's procedures are obtaining the desired results. An additional section shall be removed if the Engineer determines that there has been any change in the concrete mix or in the Contractor's procedures warranting additional inspection.

After the deck concrete has been in place for a minimum period of two (2) days, the concrete shall be tested for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer. If areas of doubtful soundness are disclosed by this procedure, the Contractor will be required to remove the forms from such areas for visual inspection after the pour has attained adequate strength. This removal of the permanent steel bridge deck forms shall be at no cost to the project.

At locations where sections of the forms are removed, the Contractor will not be required to replace the forms, but the adjacent metal forms and supports shall be repaired to present a neat appearance and assure their satisfactory retention. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing, and other defects. If irregularities are found, and it is determined by the Engineer that these irregularities do not justify rejection of the work, the concrete shall be repaired as the Engineer may direct and shall be given an ordinary surface finish. If the concrete where the form is removed is unsatisfactory, additional forms, as necessary, shall be removed to inspect and repair the slab, and the Contractor's methods of construction shall be modified as required to obtain satisfactory concrete in the slab. All unsatisfactory concrete shall be removed or repaired as directed by the Engineer.

The amount of sounding and form removal may be moderated, at the Engineer's discretion, after a substantial amount of slab has been constructed and inspected, if the Contractor's methods of construction and the results of the inspections as outlined above indicate that sound concrete is being obtained throughout the slabs.

502.03.03 Falsework. The Contractor shall be responsible for designing and constructing safe and adequate falsework which provides the necessary rigidity, supports the loads imposed, and produces in the finished structure the lines and grades indicated on the plans.

Detailed plans of falsework shall be furnished by the Contractor to the engineer in accordance with subsection 105.02, "Plans and Working Draw-

ings," for any structure having a clear cast-in-place span of twenty (20) feet or over, or any cast-in-place structure over traffic. Joists and formwork supporting slabs and overhangs of said structure shall be considered as falsework and shall be designed as such and submitted to the Engineer for approval in accordance with the requirements of this subsection of these specifications. If such plans are not satisfactory to the Engineer, the Contractor shall make such changes in them as may be required.

In addition to the detailed drawings of the falsework which are to be furnished the Engineer as specified herein, the Contractor shall also furnish the Engineer with a copy of falsework design calculations. The design calculations shall show the stresses and deflections in the load supporting members.

Approval by the Engineer of the falsework drawings or falsework inspection performed by the Engineer will in no way relieve the Contractor of full responsibility for the falsework.

The use of earth fills in lieu of falsework shall not be permitted unless otherwise indicated on the plans. The inclination of the fill slope shall not be greater than the angle of repose for the material being used. A minimum berm of three (3) feet shall be placed around the structure at the top of the fill.

Except for placement of foundation pads and piles, the construction of any unit of falsework shall not start until the Engineer has reviewed and approved the drawings for that unit.

When footing type foundations are to be used, the Contractor shall determine the bearing value of the soil and shall show the values assumed in the design of the falsework on the falsework drawings. Assumed values for both wet and dry soil conditions shall be shown.

Provisions shall be made for drainage of any excavation in the vicinity of the abutment and pier footings to prevent the ponding of water which could cause degradation of the foundation material.

The design of falsework will not be approved unless based on the use of loads and conditions which are no less severe than those described in this section and on the use of stresses and deflections which are no greater than those described in this section.

The design load for falsework shall consist of the sum of dead and live vertical loads, and an assumed horizontal load. The minimum total design load for any falsework shall be not less than one hundred (100) pounds per square foot for the combined live and dead loads regardless of slab thickness.

Dead loads shall include the weight of concrete, reinforcing steel, and forms. The weight of concrete, reinforcing steel, and forms shall be assumed to be not less than one hundred sixty (160) pounds per cubic foot for normal concrete and not less than one hundred thirty (130) pounds per cubic foot for lightweight concrete.

Live loads shall consist of the actual weight of any equipment to be supported by falsework applied as concentrated loads at the points of contact and a uniform load of not less than twenty (20) pounds per square foot applied over the area supported. In addition to the preceding live loads, a load of seventy-five (75) pounds per linear foot shall be applied to the outside edge of deck overhangs.

The assumed horizontal load to be resisted by the falsework bracing system

shall be the sum of the actual horizontal loads due to equipment, construction sequence, or other causes, but in no case shall the assumed horizontal load to be resisted in any direction be less than two (2) percent of the total dead load. The falsework shall be designed so that it will have sufficient rigidity to resist the assumed horizontal load prior to the placement of concrete.

Falsework for the support of superstructures shall be designed assuming the entire superstructure cross-section, except railing, is to be placed at one (1) time except as provided herein. Girder stems and connected bottom slabs, if placed more than five (5) days prior to the top slab, may be considered to be self-supporting between falsework posts at the time the top slab is placed provided that the distance between falsework posts does not exceed four (4) times the depth of the portion of the superstructure placed in the first pour.

Falsework footings shall be designed to carry the load imposed upon them without exceeding the estimated soil bearing values and anticipated settlements. Falsework which cannot be founded on a satisfactory footing shall be supported on piling which will be spaced, driven, and removed in a manner approved by the Engineer.

If the concrete is to be prestressed, the falsework shall be designed to support any increased or readjusted loads caused by the prestressing forces.

The support systems for form panels supporting concrete deck slabs on girder bridges shall also be considered to be falsework and designed as such.

The following maximum allowable stresses, loadings, and deflections shall be used in the design of the falsework. The stresses listed are based upon the use of undamaged, high quality materials and such stresses shall be reduced by the Contractor if lesser quality materials are to be used. The Contractor is responsible for the proper evaluation of his falsework materials and design of the falsework to safely carry the actual loads imposed.

(a) Timber:

Compression perpendicular to the grain	450 p.s.i.
Compression parallel to the grain (subject to column action correction)	1,600 p.s.i.
Extreme fiber stress in bending	1,800 p.s.i.
Horizontal shear	140 p.s.i.
Axial tension	1,200 p.s.i.
Modulus of elasticity	1.6×10^6 p.s.i.

(b) Structural Glued Laminated Timbers About x-x Axis:

Compression perpendicular to the grain	500 p.s.i.
Compression parallel to the grain (subject to column action correction)	1,600 p.s.i.
Extreme fiber stress in bending	2,000 p.s.i.
Horizontal shear	185 p.s.i.
Modulus of elasticity	1.7×10^6 p.s.i.

(c) Plywood and Plyform:

Compression perpendicular to face	425 p.s.i.
Extreme fiber stress in bending	2,000 p.s.i.
Rolling shear	110 p.s.i.
Shear perpendicular to the plys	250 p.s.i.
Modulus of elasticity	1.6×10^6 p.s.i.

Timber connections shall be designed in accordance with the stresses and loads allowed in the National Design Specifications for Wood Construction by the National Forest Products Association except that reductions in allowable

loads required therein for high moisture condition of the lumber and service conditions shall not apply.

(d) Steel:

For identified grades of steel, design stresses, except stresses due to flexural compression, shall not exceed one hundred twenty-five (125) percent of those specified in the Manual of Steel Construction as published by the AISC.

When the grade of steel cannot be positively identified, design stresses, except stresses due to flexural compression, shall not exceed either those specified in said AISC Manual for ASTM Designation A36 steel or the following:

Tension, axial and flexural	22,000 p.s.i.
Compression, axial except L/r shall not exceed one hundred twenty (120)	$16{,}000-0.38\ (L/r)^2$ p.s.i.
Shear on gross section of web	14,500 p.s.i.
Web crippling for rolled shapes	27,000 p.s.i.

For all grades of steel design stressed due to flexural compression shall not exceed the following:

Compression, flexural	$\frac{12{,}000{,}000}{Ld/bt}$ p.s.i.
but not to exceed twenty-two thousand (22,000) p.s.i. for unidentified steel or steel conforming to ASTM Designation A36 nor one hundred twenty-five (125) percent of six-tenths (0.6) Fy for other identified steel.	

In the foregoing formulas, "L" is the unsupported length; "d" is the least dimension of rectangular columns, or the width of a square of equivalent cross-sectional area for round columns, or the depth of beams; "b" is the width; "t" is the thickness of the compression flange; and "r" is the radius of gyration of the member. All dimensions are expressed in inches. "Fy" is the specified minimum yield stress, p.s.i., for the grade of steel used.

The modulus of elasticity (E) used for steel shall be 29.0×10^6 p.s.i.

(e) Deflections:

Live and impact loads will not be considered in calculating deflections.

Plywood, joists, and those other members where it is not practical to provide risers or camber strips, the limiting deflection shall not be greater than one two hundred seventieth ($1/270$) of the span.

Stringers, girders, and other load carrying members paralleling the roadway centerline where span deflection of two-tenths (0.2) inch or more is anticipated shall have risers to provide for the calculated construction dead load deflection in addition to the camber requirements as set forth in the plans. Deflection of these load carrying members will not be a limiting factor where risers are provided. Stress, in this case, is the control.

(f) Manufactured Assemblies:

The maximum loadings and deflections used on jacks, brackets, columns, joists, and other manufactured devices shall not exceed the manufacturer's recommendations except that the dead load deflection of such joists used at locations other than under deck slabs between girders shall not exceed one two hundred seventieth ($1/270$) of their spans. If requested by the Engineer, the Contractor shall furnish catalog data listing such manufacturer's recommendations or shall perform tests as necessary to demonstrate the adequacy of any such device proposed for use.

The falsework shall be constructed to conform to the falsework drawings.

The materials used in the falsework construction shall be of the quality necessary to sustain the stresses required by the falsework design. The workmanship used in falsework construction shall be of such quality that the falsework will support the loads imposed on it without excessive settlement or take-up beyond that shown on the falsework drawings. Suitable screw jacks or wedges in pairs shall be used in connection with the falsework to set the forms to grade or camber as shown on the plans, or to take up any settlement in the form work either before or during the placing of concrete. Excessive use of blocking and shims shall be cause for rejection of the falsework.

Immediately prior to placing bridge superstructure concrete, the Contractor shall check all falsework and wedges or jacks and shall make all necessary adjustments. Care shall be exercised to insure that settlement and deflection due to the added weight of the superstructure concrete will be a minimum. Suitable means such as telltales shall be provided by the Contractor to permit ready measurement of settlement and deflection as it occurs.

Falsework shall be founded on a solid footing safe against undermining, protected from softening, and capable of supporting the loads imposed on it. When requested by the Engineer, the Contractor shall demonstrate by suitable load tests that the soil bearing values assumed for the design of the falsework do not exceed the supporting capacity of the soil.

Falsework openings for traffic and pedestrians shall be as shown in the contract plans. Solid sheeting of three-fourths (3/4) inch plywood or two (2) inch planking shall be firmly attached to the vertical supports adjacent to the travelway. The sheeting shall extend vertically from one (1) foot six (6) inches above the roadway surface to seven (7) feet six (6) inches above the roadway surface. Portable temporary barrier rail, flared at each end, shall be placed along each edge of the travelway. The barrier rail shall be a minimum of one (1) foot from the vertical supports of the falsework.

502.03.04 Reinforcement. Reinforcing shall be furnished and placed as shown on the plans and in accordance with the applicable provisions of Section 505, "Reinforcing Steel," of these specifications.

502.03.05 Cofferdams and Cribs. Cofferdams for foundation construction shall be carried well below the bottom of the footings and shall be well braced and as watertight as practical. The interior dimensions of cofferdams shall be such as to provide sufficient clearance for constructing forms and, when no seal is placed, to permit pumping outside the forms.

The Contractor shall submit for approval, drawings showing proposed method of construction of cofferdams or cribs in accordance with subsection 105.02, "Plans and Working Drawings." Approval of such drawings shall in no way relieve the Contractor of his responsibility under the contract for the successful completion of the improvement. Cofferdam construction shall not start before the submitted drawings are approved and returned.

After the completion of the substructure, the cofferdams with all sheeting and bracing shall be removed to one (1) foot below the stream bed, by the Contractor, and such removal shall be performed in such a manner as not to disturb or mar the finished concrete foundation. Removal of cofferdams, sheeting, and bracing shall be considered subsidiary to other pay items of work and no further payment will be made therefor.

502.03.06 Pumping Water. Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping will be permitted during the placing of concrete or for a period of at least twenty-four (24) hours thereafter, unless it be done from a suitable pump separated from the concrete work by a watertight wall or other effective means.

Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

502.03.07 Mixing Concrete. All concrete shall be mixed and proportioned as specified in Section 501, "Portland Cement Concrete."

502.03.08 Handling and Placing Concrete. (a) General. In preparation for the placing of concrete, all sawdust, chips, and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays, and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

No concrete shall be used which does not reach its final position in the forms within the time stipulated under Section 501, "Portland Cement Concrete."

Surfaces on which concrete is to be placed shall be thoroughly moistened with water immediately before placing concrete.

Concrete shall be placed so as to avoid segregation of the material and the displacement of the reinforcement. The use of long troughs, chutes, and pipes for conveying concrete from the mixer to the forms shall be permitted only on written authorization of the Engineer. In case an inferior quality of concrete is produced by the use of such conveyors, the Engineer may order discontinuance of their use and the substitution of a satisfactory method of placing.

Open troughs and chutes shall be of metal or metal lined; where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the structure.

When placing operations would involve dropping the concrete more than five (5) feet, it shall be deposited through sheet metal or other approved pipes, except when placing concrete for thin vertical walls less than fifteen (15) inches thick, double belting may be used in lieu of adjustable pipes or elephant trunks. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars which project.

All concrete placed in concrete structures, except tremie steel concrete, shall be compacted by means of mechanical vibration subject to the following provisions:

1. The number of vibrators employed shall be ample to consolidate

incoming concrete to a proper degree within fifteen (15) minutes after it is deposited in the forms. In all cases, at least two (2) vibrators shall be available at the site of the structures in which more than twenty-five (25) cubic yards is being placed.

2. The vibration shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.

3. Vibrators shall be capable of transmitting vibration to the concrete at frequencies of not less than four thousand five hundred (4,500) impulses per minute.

4. The intensity of vibration shall be such as to visibly affect a mass of concrete of one (1) inch slump over a radius of at least eighteen (18) inches.

5. Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms:

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued at any one (1) point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

6. Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.

7. Vibration shall be supplemented by such spading as necessary to insure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

8. The provisions of this article shall apply to the filler concrete for steel grid floor except that the vibrator shall be applied to the steel.

9. Vibrators used to consolidate concrete containing epoxy-coated reinforcing steel shall have a resilient covering to prevent damage to the coating.

Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed upon the reinforcement steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcement steel.

(b) Culverts. In general, the base slab or footings of box culverts shall be placed and allowed to set before the remainder of the culvert is constructed. In this case, suitable provision shall be made for bonding the sidewalls to the culvert base.

Before concrete is placed in the sidewalls, the culvert footing shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material and the surface carefully chipped and roughened in accordance with the method of bonding construction joints as specified therein.

Walls and top slab shall not be constructed as a monolith on box culverts where the depth of pour below the bottom of the top slab exceeds four (4) feet unless approved in writing by the Engineer. When this method of construction is used any necessary construction joints shall be vertical and at right angles to the axis of the culvert.

When walls are poured separately, in non-rigid frame box culverts, the concrete in the walls shall be placed and allowed to set a minimum of two (2) hours before the top slab is placed.

When walls are poured separately, in rigid frame box culverts, the concrete in the walls shall be placed and allowed to set a minimum of twelve (12) hours before the top slab is placed.

Each wing wall shall be constructed, if possible, as a monolith. Construction joints, where unavoidable, shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line.

(c) Girders, Slabs, and Columns. When the height of any point of web is more than three (3) feet from the bottom of the top slab to bottom of the web for "T" beams, or to construction joint for box girders, the top slab shall be poured independent of webs.

Concrete in slab spans shall be placed in one (1) continuous operation for each span unless otherwise specified.

Concrete in columns shall be placed in one (1) continuous operation, unless otherwise specified. The concrete shall be allowed to set at least twelve (12) hours before the succeeding pour is started.

Before pouring concrete for superstructure, the forms on base of columns shall be exposed sufficiently to determine the character of the concrete in the columns.

502.03.09 Pumping Concrete. Placement of concrete by pumping will not be permitted unless authorized in writing by the Engineer. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete.

Where concrete is conveyed and placed by mechanically applied pressure the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned.

The use of aluminum conduit for concrete pumping is prohibited.

502.03.10 Concrete Deposited Under Water. If conditions render it impossible or inadvisable, in the opinion of the Engineer, to dewater excavations before placing concrete, the Contractor shall deposit under water, by means of a tremie or a concrete pump, a seal course of concrete of sufficient thickness to thoroughly seal the cofferdam. The concrete shall be carefully placed in a compact mass and shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit.

The use of an aluminum tremie for placing concrete is prohibited.

A tremie shall consist of a watertight tube having a diameter of not less than ten (10) inches with a hopper at the top. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete.

Concrete pump discharge tubes and tremie tubes shall be equipped with a device that will prevent water from entering the tube while charging the tube with concrete. Such tubes shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering when necessary to retard or stop the flow of concrete. The tubes shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tubes shall contain sufficient concrete to prevent any water entry. The flow shall be continuous until the work is completed and the resulting concrete seal shall be monolithic and homogeneous.

Concrete deposited in water shall be Class A or Class AA with ten (10) percent extra cement added. The exact thickness of the seal will depend upon the hydrostatic head, bond and spacing of piles, size of cofferdam, and other related factors, but in no case shall the seal be less than two (2) feet in thickness, unless otherwise shown on the plans. Before dewatering, the concrete in the seal shall be allowed to cure for not less than five (5) days after placing.

If a seal which is to withstand hydrostatic pressure is placed in water having a temperature below forty-five (45) degrees Fahrenheit, the curing time before dewatering shall be increased. Periods of time during which the temperature of the water has been continuously below thirty-eight (38) degrees Fahrenheit shall not be considered as curing time. After sufficient time has elapsed to insure adequate strength in the concrete seal, the cofferdam shall be dewatered and the top of the concrete cleaned of all scum, laitance, and sediment. Before fresh concrete is deposited, local high spots shall be removed as necessary to provide proper clearance for reinforcing steel.

502.03.11 Construction Joints. Construction joints shall be made only where located on the plans or shown in the pouring schedule, unless otherwise approved by the Engineer.

Construction joints where the placing of concrete is delayed until the concrete has taken its initial set and for which no expansion is provided, shall be planned in advance and shall be subject to approval by the Engineer. The placing of concrete shall be continuous from joint to joint. These joints shall be perpendicular to the principal lines of stress and, in general, located at points of minimum shear. Only joints shown on the plans will be permitted in a cantilevered member. Horizontal joints at piers and abutments, except where specified, shall generally be avoided, and when used shall not be located within two (2) feet of the normal water level.

Unless otherwise specified, construction joints shall be struck off but not troweled.

When making a horizontal construction joint, care shall be taken to have the concrete as dry as possible, and any excess water or creamy material shall be drawn off before the concrete sets. On all exposed surfaces, the line of the proposed joint shall be made truly straight by taking a temporary straightedge

on the inside of the form and pouring the concrete so that it will set flush with the edge as provided.

To avoid visible joints as far as possible upon exposed faces the top surfaces of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feather edge" might be produced at a construction joint, as in the sloped top surface of a wing wall, an insert form work shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than six (6) inches in the succeeding layer.

When the work is unexpectedly interrupted by breakdowns, storm, or other causes, and the concrete as placed would produce an improper construction joint, the Contractor shall either rearrange the freshly deposited concrete, or continue by hand mixing, if necessary, until a suitable arrangement is made for a construction joint. When such a joint occurs at a section on which there is shearing stress, he shall provide adequate mechanical bond across the joint by inserting reinforcing steel, or by some other means satisfactory to the Engineer, which will prevent a plane of weakness.

In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance, or other soft or porous materials by one (1) of the following methods:

(a) Concrete surface of fresh concrete (not more than eight (8) hours after placement) shall be cleaned with air and water jets in such a manner that the surface is thoroughly cleaned and the aggregate is not loosened.

(b) Hardened concrete surface (more than eight (8) hours after placement) shall be cleaned by abrasive blast methods in such a manner that the aggregate is not loosened or the edges of the concrete shattered.

The surface of the joint shall be thoroughly washed with clean water and the forms tightened to close contact with the previously placed work, after which the concreting may proceed. The surface of the joint shall be wet just prior to placing new concrete.

502.03.12 Removal of Falsework and Forms.

(a) General.

1. Method of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without the approval of the Engineer. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

2. Compressive strengths will be determined by Test Methods Nos. Nev. T475 and T428 and will be considered information tests only and not acceptance tests as described in subsection 501.02.04, "Concrete Making Properties."

3. The time and strength requirements placed on falsework removal shall also pertain to the removal of earth fills used in lieu of falsework. The slopes of the earth fill shall also be retained as originally placed until the same time and strength requirements are met.

4. Attention is directed to subsection 501.03.09, "Curing."

(b) Falsework. Falsework supporting any span of a simple span bridge shall not be released before ten (10) days after the last concrete, excluding

concrete above the bridge deck, has been placed. Unless otherwise permitted by the Engineer, falsework supporting any span of a continuous or rigid frame bridge shall not be released before ten (10) days after the last concrete, excluding concrete above the bridge deck, has been placed in that span and in the adjacent portions of each adjoining span for a length equal to at least one-half (1/2) the length of the span where falsework is to be released.

In the event of cold weather, all time requirements shall be increased one (1) day for every day the curing time is increased as prescribed in subsection 501.03.10(b), "Cold Weather—General."

Falsework for cast-in-place prestressed portions of structures shall not be released until after the prestressing steel has been tensioned, the ducts have been grouted, and the grout has been in place for twenty-four (24) hours.

Falsework supporting any span of a continuous or rigid frame bridge shall not be removed until all required prestressing has been completed in that span and in the adjacent portions of each adjoining span for a length equal to at least one-half (1/2) the length of the span where falsework is to be released.

Falsework for arch bridges shall be removed uniformly and gradually, beginning at the crown and working toward the springing, to permit the arch to take its load slowly and evenly. Falsework for adjacent arch spans shall be struck simultaneously.

Falsework supporting overhangs, deck slabs between girders and girder stems which slope forty-five (45) degrees or more off vertical shall not be released before seven (7) days after the deck concrete has been placed.

Falsework supporting the sides of the girder stems which slope less than forty-five (45) degrees off vertical may be removed prior to placing deck slab concrete, providing a reshoring system is installed. The reshoring system shall consist of lateral supports which are designed to resist all rotational forces acting on the stem, including those caused by the placement of deck slab concrete. Such lateral supports shall be installed immediately after each form panel is removed and prior to the release of supports for the adjacent form panel.

Falsework for bent caps which will support steel or precast concrete girders shall not be released before seven (7) days after the cap concrete has been placed. Girders shall not be erected onto such bent caps until the concrete in the cap has attained a compressive strength of two thousand six hundred (2,600) pounds per square inch or eighty (80) percent of the specified strength, whichever is higher.

In addition to the above requirements, no falsework for bridge spans shall be released until the supported concrete has attained a compressive strength of two thousand six hundred (2,600) pounds per square inch or eighty (80) percent of the specified strength, whichever is higher.

Falsework for box culverts and other structures with decks lower than the roadway pavement and with span lengths of fourteen (14) feet or less shall not be released until the last placed concrete has attained a compressive strength of one thousand five hundred (1,500) pounds per square inch, provided that curing of the concrete is not interrupted. Falsework removal for other box culverts shall conform to the requirements for release of bridge falsework.

Falsework for arch culverts shall not be released before forty (40) hours

after the supported concrete has been placed. All falsework materials shall be removed at least two (2) feet below the surface of the original ground or original stream bed. When falsework piling is driven within the limits of ditch or channel excavation areas, the falsework piling within such areas shall be removed to at least two (2) feet below the bottom and side slopes of said excavated areas.

All debris and refuse resulting from the work shall be removed and the premises left in a neat and presentable condition.

(c) Forms. Forms on parapets and curbs shall not be removed until concrete has set sufficiently to prevent distorting or cracking.

Forms for columns, walls, sides of beams, girders, and all other parts, which are not subjected to stress, shall not be removed until the concrete has reached a minimum age of twelve (12) hours.

Forms which are subjected to stresses shall not be removed until the requirements of (b) above have been satisfied, unless otherwise approved by the Engineer.

Form removal and replacement with shoring will not be permitted, except as provided in (b) above.

502.03.13 Expansion and Fixed Joints and Bearings. Bridge expansion joints shall comply to the tolerances specified for bridge decks in subsection 502.03.16, "Finish of Horizontal Surfaces."

All joints shall be constructed according to details shown on the plans and the following:

(a) Open Joints. Open joints shall be placed in the locations shown on the plans and shall be constructed by the insertion and subsequent removal of a wood strip, metal plate, or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the plans.

(b) Filled Joints. Poured expansion joints shall be constructed similar to open joints. When premolded types are specified, the filler shall be placed in correct position as the concrete on one (1) side of the joint is placed. When the form is removed, the concrete on the other side shall be placed.

In order to obtain proper bond between the concrete and joint fillers, the Contractor will be required to carry on his operations in a manner which will insure that joint recesses are free of curing compound at the time the joint material is placed.

(c) Steel Joints. The plates, angles, or other structural shapes shall be accurately shaped, at the shop, to conform to the section of the concrete floor. The fabrication and painting shall conform to the requirements of these specifications covering those items. When called for on the plans or in the special provisions the materials shall be galvanized in lieu of painting. Care shall be taken to insure that the surface in the finished plane is true and free of warping. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be that designated on the plans at normal temperature, and care shall be taken to avoid impairment of the clearance in any manner.

(d) Waterstops. Waterstops shall be furnished and installed in accordance with the details shown on the plans. The edge of the waterstop shall be supported in a manner satisfactory to the Engineer.

Waterstops shall be manufactured from either natural rubber, synthetic rubber, or polyvinyl chloride (PVC), at the option of the Contractor. Materials shall conform to the requirements of subsection 707.03.03, "Waterstops."

Waterstops shall be manufactured with an integral cross section which shall be uniform within plus or minus one-eighth (1/8) inch in width, and the web thickness or bulb diameter, within plus one-sixteenth (1/16) inch and minus one-thirty-second (1/32) inch. No splices will be permitted in straight strips. Strips and special connections pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous, and free from all porosity. All junctions in the special connection pieces shall be full molded. During the vulcanizing period the joint shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross section.

Field splices for either natural or synthetic rubber waterstops shall be either vulcanized; mechanical, using stainless steel parts; or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a full size tensile strength of 600 $\frac{\text{(width in inches)}}{6}$ pounds.

Field splices for polyvinyl chloride waterstops shall be formed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not char the plastic.

Waterstops, when being installed, shall be cut and spliced at changes in direction as may be necessary to avoid buckling or distortion of the web or flange.

(e) Bearing Devices. Bearing plates, bars, rockers, assemblies, and other expansion or fixed devices shall be constructed in accordance with the details shown on the plans and shall be hot-dip galvanized after fabrication in accordance with Section 715, "Galvanizing." Structural steel and cast steel shall conform to the provisions in Section 506, "Steel Structures," for those items.

The bearing plates shall be set level and the rockers or other expansion devices shall be set to conform to the temperature at the time of erection or to the setting specified.

When bearing assemblies or masonry plates are shown on the plans to be placed (not embedded) directly on concrete, the concrete bearing areas shall be constructed slightly above grade and shall be finished by grinding or other approved means to a true level plane which shall not vary perceptibly from a straightedge placed in any direction across the area. The finished plane shall not vary more than one-eighth (1/8) inch from the elevation shown on the plans.

When elastomeric bearing pads, elastic bearing pads, or preformed fabric pads are shown on the plans, the concrete surfaces on which pads or packing are to be placed shall be wood float finished to a level plane which shall not

vary more than one-sixteenth (1/16) inch from a straightedge placed in any direction across the area. The finished plane shall not vary more than one-eighth (1/8) inch from the elevation shown on the plans.

Where bearing assemblies or masonry plates are shown on the plans to be placed on grout pads, they shall be placed in accordance with the provisions in subsection 506.03.28, "Bearing and Anchorage."

(f) Elastomeric Bearing Pads. Pads shall be plain or laminated as indicated on the plans. Laminated pads shall consist of alternate laminations of elastomer and metal or elastomer and fabric bonded together in accordance with Section 725, "Elastomeric Bearing Pads." If no lamination increment is indicated the pads shall be laminated every one-half (1/2) inch.

Elastomeric bearing pads shall be of the durometer indicated on the plans. If no durometer is indicated, the pads shall be fifty (50) durometer.

Pads shall be installed where designated on the plans.

(g) Preformed Elastomeric Joint Seal (Compression Joint Seal). 1. General. This work shall consist of furnishing and installing preformed elastomeric joint seals with a lubricant adhesive. The seals shall be installed at locations and as detailed on the plans and in accordance with these specifications.

2. Materials. Preformed elastomeric joint seals shall conform to ASTM Designation D3542. The seals shall consist of a multiple-web design, function only by compression between the faces of the joint, allow for movement of the bridge, and seal the joint against admission of moisture. The minimum nominal depth of the seal shall be at least ninety-five (95) percent of the uncompressed width. The movement rating of each seal, as determined by ASTM Designation D3542, shall be not less than the movement rating as shown on the plans.

The lubricant-adhesive shall conform to ASTM Designation D4070.

3. Joint Preparation. Preformed elastomeric joint seals shall be installed in saw cut grooves as shown on the plans, or as directed by the Engineer. The sides of saw cut grooves shall be cut simultaneously to a uniform width and depth. All debris, concrete spillage, and foreign material shall be removed from the groove. The Contractor shall repair all spalls, fractures, or voids in the concrete surfaces of the joint groove. The lips of the saw cut shall be bevelled one-fourth (1/4) inch by grinding. Prior to placement of the seal, the joint shall be cleaned by abrasive blast cleaning and the residue removed by high pressure air jets. Water stops shall be protected from the abrasive blasts.

Saw cutting is not required for armored metal joints. Joints installed in curbs, sidewalks, barrier rails, or railings will not require saw cutting provided the grooves are formed to the same dimensions as the saw cutting of the deck.

4. Installation. Shop splices shall have no visible offset of exterior surfaces, and shall show no evidence of bond failure. Field splices shall not be allowed.

At the open ends of the seal, each cell shall be filled to a depth of three (3) inches with an open cell polyurethane foam or other means as approved by the Engineer.

The seal shall be installed with equipment which will not twist or distort the seal, elongate the seal longitudinally or otherwise cause damage to the seal or to the concrete forming the groove.

Lubricant-adhesive shall be liberally applied to the sides of the seal and vertical surfaces of the groove immediately prior to installation, in accordance with directions furnished by the manufacturer. No material shall be used which has skinned over or which has settled in the containers, to the extent that it cannot be easily redispersed by hand stirring to form a smooth uniform product.

After installation the top edges of the seal shall be in a plan normal to the sides of the groove.

5. Certification. A Certificate of Compliance, accompanied by a certified test report, shall be furnished for each lot of preformed elastomeric joint seal and lubricant-adhesive. The certified test report for the elastomeric joint seal shall include the movement rating of the seal. The testing shall be performed by the manufacturer or an independent testing agency.

The Engineer at his option may sample each lot of prefabricated joint seal and/or lubricant adhesive. Joint seal samples shall be twenty-four (24) inches in length. Samples shall be taken at random from stock at the jobsite or at a location acceptable to the Engineer and the manufacturer.

The Certificates of Compliance and certified test results shall be submitted to the Engineer thirty (30) days in advance of proposed use. The Engineer at this time will determine if sampling is required.

502.03.14 Curing. Curing of formed concrete shall conform to the requirements of subsection 501.03.09, "Curing," and attention is directed thereto.

502.03.15 Patching. After removal of forms, all metal ties except those to be used to aid future forming shall be cut back and patched. Honeycomb shall be removed and patched. When honeycomb is determined by the Engineer to be excessive, it shall be sufficient cause for rejection of all or a part of the structure.

Loose or broken material shall be chipped away until a dense, uniform surface exposing solid coarse aggregate is obtained. Feather edges shall be cut away to form a face perpendicular to the surface being patched. All surfaces of the cavity shall be thoroughly saturated with water. Contact surfaces shall be coated with an approved bonding agent. Bonding agent may be mixed with mortar in lieu of coating the contact surfaces.

Patching mortar shall consist of one (1) part cement and two (2) parts sand. The mortar shall contain only enough water to permit placing and packing. White cement or other approved tinting materials shall be used on all surfaces where an "ordinary finish" is final. For patching large or deep areas, coarse aggregate shall be added to the patching mortar.

The patching mortar shall be thoroughly tamped into place. Mortar may be placed pneumatically when approved by the Engineer. The surface of the mortar shall be floated with a wooden float before initial set takes place. The patch shall present a neat and workmanlike appearance.

The patched surface shall be cured by one (1) of the methods described in subsection 501.03.09, "Curing."

Patching is the only treatment required for those portions of the structure below ground.

When an item of "Concrete Bridge Deck Repair" is included in the proposal, the Contractor shall notify the Engineer two (2) weeks in advance of the anticipated date that the existing bridge deck(s) will be exposed and available for inspection and testing to determine the extent of defective areas requiring repair.

Repair of existing concrete bridge decks shall be accomplished as hereinafter provided.

(a) The areas to be repaired shall be designated by the Engineer. The concrete shall then be broken and removed to such depth that sound concrete is exposed over the entire area. Edges of the patch area shall be excavated in a manner that will result in an approximately vertical face and a "feather edge" will not be permitted. Saw cutting around the perimeter of a patch will not be permitted due to the possibility of cutting reinforcing steel. Regardless of the method employed to excavate the area to be patched, care shall be exercised to prevent damage to reinforcing steel and concrete which will remain in place.

(b) Extensive rust shall be removed from reinforcing steel as directed by the Engineer.

(c) After loose material has been removed, the excavation shall be blown out with compressed air or flushed with water. Excess water shall be removed. In the event compressed air is used, extreme care must be exercised to insure that no oil from the compressor is deposited on the contact surfaces.

(d) Following cleaning of the excavated area and prior to placement of the concrete patch, Concressive 1001–LPL, manufactured by Adhesive Engineering Company, or an approved equal shall be applied to the area to be patched. The Concressive 1001–LPL shall be applied to the entire surface to be patched and shall be applied according to the manufacturer's recommendations and instructions.

(e) Several different concrete mixtures shall be used, depending on the depth of the patch. For purposes of determining the concrete mixture suitable for a given patch, the following specifications will apply for "thin" patches (two (2) inches and less in depth) and "normal" patches (over two (2) inches in depth). However, at the option of the Contractor, an epoxy concrete may be used. The epoxy must be suitable for use in freeze-thaw environments, must be formulated for use in bonding the epoxy concrete to old Portland cement concrete, and must be able to provide a twenty-eight (28) day compressive strength of four thousand (4,000) p.s.i. or four thousand five hundred (4,500) p.s.i. to the epoxy concrete as determined by the Engineer. The epoxy and the mix for the epoxy concrete shall be approved by the Engineer before use.

Thin patches (two (2) inches and less in depth):

	Thickness of Patch		
	½"	1"	2"
Cement	94 lbs.	94 lbs.	94 lbs.
Total water 5 gals. sk. (includes free moisture in aggregate)	42 lbs.	42 lbs.	42 lbs.
Aggregate*			
Fine	190 lbs.	170 lbs.	190 lbs.
Coarse	115 lbs.	170 lbs.	280 lbs.
Max. Size	3/8"	½"	1"
*Based on saturated surface dry aggregate, specific gravity 2.65.			
Air Entrainment	4–7 percent		
Slump	Under 70° F. 1"–2"		
	Over 70° F. 3"–4"		

Normal patches (over two (2) inches in depth):

Class A or EA concrete, as determined by the Engineer, conforming to the requirements of Section 501 of these specifications.

(f) A vibrating screed shall be used to consolidate all patching concrete regardless of thickness and the use of a bull float will not be permitted. Except as hereinafter set forth for joints, the finish obtained by the vibrating screed shall be considered the final finish.

(g) All joints in the original slab shall be duplicated and joints shall be provided between the patch and any abutting slabs in a manner that will allow the patch to move identically with the base slab.

(h) Curing shall commence immediately upon completion of finishing. Curing shall be in accordance with subsection 501.03.09(b), "Water Method," except that such curing shall continue for a minimum of four (4) hours after finishing. Upon completion of the above curing period, an approved membrane curing compound shall be applied in accordance with subsection 501.03.09(c), "Curing Compound Method."

502.03.16 Finish of Horizontal Surfaces. Concrete bridge decks shall be struck off with a template immediately after pouring to provide the proper crown and shall be finished to a smooth even surface by means of both longitudinal and transverse wooden floats, or other suitable means. When a transversely broomed finish is used, the allowable variations noted herein shall be independent of the depth of the broom marks. No variations will be permitted that will tend to prevent complete drainage on all parts of the deck. The surface shall be corrected by grinding off the high spots, or other approved method, as may be required in order to conform to these limits. An edging tool shall be used at expansion joints and deck edges not armored.

Approach slabs to concrete bridges shall be finished to the tolerances specified for bridge decks.

FINISHING BRIDGE DECKS

A smooth riding surface of uniform texture, true to the required grade and cross section, shall be obtained on all bridge roadway decks. The Contractor shall use finishing machines conforming to the requirements specified herein for finishing bridge roadway deck concrete. Hand tools may be used to supplement finishing machines when permitted by the Engineer.

Finishing of concrete placed in bridge decks shall consist essentially of striking off the surface of the concrete as placed and floating with longitudinal floats the surface so struck off.

The placing of concrete in bridge roadway decks will not be permitted until the Engineer is satisfied that the rate of producing and placing concrete will be sufficient to complete the proposed placing and finishing operations within the scheduled time, that experienced finishing machine operators and concrete finishers are employed to finish the deck, that fogging equipment and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use. Finishing machines shall be set up sufficiently in advance of use to permit inspection by the Engineer during the daylight hours before each pour.

The adjustment and operation of deck finishing machines shall be verified by moving the machine over the full length of the deck section to be placed and traversing the float completely across all end bulkheads before placement of concrete is begun.

Unless adequate lighting facilities are provided by the Contractor, the placing of concrete in bridge decks shall cease at such time that finishing operations can be completed during daylight hours.

Supports for rails for the support of finishing machines shall be completely in place and firmly secured for such a length that will insure continuity of operations for concrete placement before placing of concrete will be permitted. Rails for finishing machines shall extend beyond both ends of the length of concrete placement to a distance that will permit the float of the finishing machine to fully clear the concrete to be placed. Rails shall be adjustable for elevation and shall be set to elevations, with allowance for anticipated settlement, camber, and deflection of falsework, as required to obtain a bridge roadway deck true to the required grade and cross section. Rails shall be of a type and shall be so installed that no springing or deflection will occur under the weight of the finishing equipment, and shall be so located that finishing equipment may operate without interruption over the entire bridge roadway deck being finished. Rails shall be adjusted as necessary to correct for unanticipated settlement or deflection which may occur during finishing operations.

Should settlement or other unanticipated events occur, which in the opinion of the Engineer would prevent obtaining a bridge deck conforming to the requirements of these specifications, placing of deck concrete shall be discontinued until corrective measures satisfactory to the Engineer are provided. In the event satisfactory measures are not provided prior to initial set of the concrete in the affected area, the placing of concrete shall be discontinued and a bulkhead installed at a location determined by the Engineer. All concrete in place beyond the bulkhead shall be removed.

Unless otherwise permitted by the Engineer, bridge deck concrete shall be placed and struck off in a uniform heading approximately parallel to the bridge pier or bent caps. The rate of placing concrete shall be limited to that which can be finished before the beginning of initial set, except that concrete for the deck surface shall not be placed more than ten (10) feet ahead of strike off. Strike off and consolidation shall be completed within fifteen (15) minutes after the concrete is in place.

After the concrete has been placed and consolidated, the surface of the concrete shall be carefully struck off by means of a self-propelled mechanical finishing machine operating on rails.

Following strike off, longitudinal floating of the concrete shall be performed by means of a hand-operated pipe float or float board or a finishing machine equipped with a longitudinal float. The longitudinal float on the finishing machine shall have a length of not less than eight (8) feet nor more than twelve (12) feet.

Finishing machines used for strike off having a wheel base six (6) feet or less shall be followed by hand-operated longitudinal floating. All the provisions in this section pertaining to hand-operated float boards shall apply to float boards when used for longitudinal floating.

Longitudinal floats, either hand-operated or machine-operated, shall be used with the long axis of the float parallel to the centerline of the bridge roadway. The float shall be operated with a combined longitudinal and transverse motion planing off the high areas and floating the material removed into the low areas. Each pass of the float shall lap the previous pass by one-half (1/2) the length of the float. Floating shall be continued until a smooth riding surface is obtained.

Hand-operated float boards shall be from twelve (12) feet to sixteen (16) feet long, ribbed and trussed as necessary to provide a rigid float, and shall be equipped with adjustable handles at each end. The float shall be wood, not less than one (1) inch thick and from four (4) inches to eight (8) inches wide. Adjusting screws spaced not to exceed twenty-four (24) inches on centers shall be provided between the float and the rib. The float board shall be maintained free of twist and true at all times.

Hand-operated float boards shall be operated from transverse finishing bridges. The finishing bridges shall span completely the roadway area being floated and a sufficient number of finishing bridges shall be provided to permit operation of the floats without undue delay. Not less than two (2) transverse finishing bridges shall be provided when hand-operated float boards are used. When a finishing machine is used for longitudinal floating, one (1) finishing bridge equivalent to the transverse finishing bridge specified herein shall be furnished for use by the Engineer.

All finishing bridges shall be of rigid construction and shall be free of wobble and springing when used by the operators of longitudinal floats and shall be easily moved.

In advance of curing operations, the concrete surface shall be first textured with a drag strip of burlap and then with a mechanical spring steel tine device which will form grooves transversely to the centerline. The tines shall be rectangular in cross section, three thirty-seconds (3/32) to one-eighth (1/8) inch wide and four (4) to five (5) inches long. Tines shall be spaced one and one-half (1 1/2) inches center to center and be of sufficient thickness and resilience to result in grooves one-eighth (1/8) to one-fourth (1/4) inch deep in the finished concrete bridge deck.

The speed of the tine machine shall be slow enough so that the tines will penetrate the surface to the desired length, yet fast enough so the machine can keep up with the concrete placement operation.

A one (1) inch gap shall be left between each tine strip to prevent overlapping the tined surface and producing a weak surface area.

The surface adjacent to the curb or barrier rail shall be finished to a smooth troweled texture approximately twelve (12) inches from the face of the curb or barrier rail on the low side or sides of the deck as approved by the Engineer.

Fogging equipment to be furnished shall be capable of applying water to the concrete in the form of a fine fog mist in sufficient quantity to curb the effects of rapid evaporation of mixing water from the concrete on the deck resulting from wind, high temperature, or low humidity, or a combination of these factors. The fog mist shall be applied at the times and in the manner directed by the Engineer.

Immediately following completion of the deck finishing operations, the concrete in the deck shall be cured as specified in subsection 501.03.09, "Curing."

The finished surface of the concrete shall be tested by means of a straightedge twelve (12) feet long. The surface shall not vary more than one one-hundredth (0.01) foot from the lower edge of the straightedge. All high areas in the hardened surface in excess of one one-hundredth (0.01) foot as indicated by testing shall be removed by abrasive means. After grinding by abrasive means has been performed, the surface of the concrete shall not be smooth or polished but shall have a surface texture satisfactory to the Engineer. Ground areas shall be of uniform texture and shall present neat and approximately rectangular patterns.

Where the concrete of the bridge deck is to be covered by bituminous surfacing, earth, or other cover, one (1) inch or more in thickness, the surface of the concrete shall not vary more than three one-hundredths (0.03) foot from the lower edge of the twelve (12) foot straightedge.

Bridge deck surfaces under the curbs, railings, and sidewalks shall be struck off to the same plane as the roadway and left undisturbed when future widening is shown on the plans.

The top and face of the finished parapet and curb shall be true and straight, and the top surface shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge twelve (12) feet long is laid on top of the face of the curb or on the face of the parapet, the surface shall not vary more than one-eighth (1/8) inch from the theoretical grade or alignment in twelve (12) feet, except that proper allowance shall be made for curves and camber.

502.03.17 Formed Surfaces Requiring Finishing. Surfaces requiring a "fine surface finish" (FSF) or "exposed aggregate finish" will be noted on the plans. All exposed surfaces of structures not requiring a fine surface or exposed aggregate finish shall be given an ordinary surface finish unless otherwise specified on the plans or in these specifications. Only exposed surfaces of structures, to one (1) foot below finished grade, will require finishing (ordinary or fine).

The inside of the culvert barrels, except for a horizontal distance into the ends equal to the height when the end of culvert may be seen from a travelled way, will not be defined as an exposed surface.

502.03.18 Ordinary Surface Finish. The surface shall have all holes

left by form ties and all other holes one-fourth (1/4) inch or more in largest diameter repaired in accordance with subsection 502.03.15, "Patching." The surface shall be true and even, free from stone pockets, depressions, or projections beyond the surface. All fins and projections shall be knocked off or ground flush. Offsets greater than one-eighth (1/8) inch shall be filled or tapered back to present a smooth appearance. All patches shall be of such color and appearance that will blend with the surrounding surface.

Except as provided herein, all form bolts and any metal placed for the convenience of the Contractor shall be removed to a depth of at least one (1) inch below the surface of the concrete. All rock pockets and other unsound concrete shall be removed. The resulting holes or depressions shall be cleaned and filled with mortar. Form bolts projecting into the cells of box girders need not be removed unless deck forms are removed from the cells, in which case such bolts shall be removed flush with the surface of the concrete.

If rock pockets, in the opinion of the Engineer, are of such an extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of the portions of the structure affected.

502.03.19 Fine Surface Finish. Where it is indicated on the plans that a fine surface finish is required, the finish shall conform to the requirements for "bonded grout finish" or "class 1 surface finish." The type of fine surface finish shall be as called for on the plans. Before any fine surface finish is applied, the surface shall first receive an ordinary surface finish.

(a) Bonded Grout Finish. This finish shall be an application of grout consisting of pigments and suitable mineral fillers combined with a suitable binder. The mineral filler shall pass a No. 30 sieve. The binder shall be either an epoxy, acrylic, vinyl, polyester, or phenolic resin. This mixture may be thinned by not more than twenty-five (25) percent water by volume.

The finish shall be of such consistency and composition that it will provide a uniform appearance in color and texture when applied as specified below, and shall meet the requirements set forth in Section 727, "Concrete Surface Finishing Material."

The Contractor shall furnish two (2) copies of a certificate issued by the manufacturer, certifying that the product complies with the specifications. Said certificates shall be delivered to the Engineer at least thirty (30) days in advance of placing the material.

The grout shall be applied by spray, using conventional spray equipment with a one-quarter (1/4) inch round spray head. Material shall be supplied by either a surge pump with a twelve (12) to one (1) ratio or an auger type pump, with air pressure sufficient to achieve uniform texture. Worn spray heads shall be replaced as required to achieve a uniform finish.

Application shall be at the rate of twenty-four (24) to fifty (50) square feet per gallon.

The finished surface shall present a uniform appearance.

Color of bonded grout finish to be applied will be as shown on the plans. Where the color of the bonded grout finish that is to be applied is not indicated on the plans it shall conform to Federal Color No. 37875 as shown in Table IX of Federal Standard No. 595a.

Surfaces of concrete shall be thoroughly cleaned just before applying bonded grout finish. This may be accomplished by:

1. Application of a ten (10) percent solution of muriatic acid or a twenty-five (25) percent zinc sulfate solution, which shall be applied as to completely remove any oily film and to lightly etch the surface; or
2. Thorough cleaning by approved abrasive as required to remove all oily film.

Following cleaning, the surface shall be thoroughly rinsed with clean water. Surface to be finished need not be completely dry, but may be damp, prior to application of finish.

CAUTION: Do not apply finish unless temperature is at least forty (40) degrees Fahrenheit and is rising. Application shall be stopped if temperature is forty (40) degrees Fahrenheit and is dropping.

(b) Class 1 Surface Finish. Class 1 surface finish shall consist of finishing the surfaces of the structure as necessary to produce smooth, even surfaces of uniform texture and appearance, free of unsightly bulges, depressions, and other imperfections. The degree of care in building forms and character of materials used in form work will be a contributing factor in the amount of additional finishing required.

After completion of the ordinary surface finish, areas which do not exhibit the required smooth, even surface of uniform texture and appearance shall be sanded with power sanders or other approved abrasive means until smooth, even surfaces of uniform texture and appearance are obtained. The use of power carborundum stones or disks may be required to remove bulges and other imperfections.

The Engineer shall be the sole judge as to the amount of finishing required.

502.03.20 Formed Exposed Aggregate Finish. Where it is indicated on the plans that specific portions of structures are to receive an exposed aggregate finish, said exposed aggregate finish shall conform to the following requirements:

Forms for surfaces which are to receive an exposed aggregate finish shall be given a minimum of two (2) coats of retardant of sufficient strength to cause a one-fourth (1/4) inch (total) etch to the finished surface. The retardant shall be Ag Reveal, Preco "Hi-V," Preco "Tuf-Cote," Sonaborne, or an approved equal.

Forms shall be removed from all concrete surfaces requiring an exposed aggregate finish within fourteen (14) days after placement of the concrete.

After stripping the forms, or as soon thereafter as practicable as determined by the Engineer, the concrete shall be washed to remove all loose material and otherwise cleaned to provide the specified etch (one-fourth (1/4) inch) as approved by the Engineer.

Normally, a minimum amount of sandblasting will be permitted for blending purposes only. Should major amounts of sandblasting be required, the entire area shall be so treated subject to approval by the Engineer. Sandblasting, if permitted or required by the Engineer, shall be accomplished as soon after completion of the washing phase as is practical as determined by the Engineer.

All exposed aggregate surfaces shall be sealed as hereinafter provided.

The sealer shall be a clear non-silicone product with solids completely dissolved. The product shall be non-staining and a surface residue shall not form after curing. The solids shall become an integral part of the masonry and shall be of a non-diminishing type. Any product which requires agitation will not be accepted. The sealer shall be applied at the rate recommended by the manufacturer, and as approved by the Engineer.

Prior to placing concrete in any area which is to have an exposed aggregate surface as specified above, the Contractor shall construct a two (2) foot by two (2) foot exposed aggregate test panel. This panel shall be used to test the acceptability of the exposed aggregate finish and upon approval by the Engineer, shall become a referee panel and the property of the Department. Rejected panels shall be replaced by new samples, for approval by the Engineer. All exposed aggregate surfaces shall conform to the referee panel.

502.03.21 Live Loads. Live loads such as traffic or dead loads such as superimposed earth loads shall not be allowed on post-tensioned structures until all post-tensioning has been completed and the concrete has reached an age of fourteen (14) days and it has reached the twenty-eight (28) day strength required.

Live loads such as traffic or dead loads such as superimposed earth loads or steel beams shall not be allowed on any portion of a conventionally reinforced structure until concrete has reached an age of fourteen (14) days and it has reached the twenty-eight (28) day strength required. Live loads may be allowed on a conventionally reinforced structure when the concrete has reached an age of eight (8) days and the twenty-eight (28) day strength required in cases where Type III (high-early strength) cement is used with the approval of the Engineer. Approach slabs shall be treated as concrete paving under Section 409 of these specifications.

In the event of cold weather, the above specified time requirement shall be increased one (1) day for every day the curing time is increased as prescribed in the subsection 501.03.10(b), "Cold Weather—General."

In case the concrete does not reach the desired strength within the time specified, the Engineer shall determine when the strength is adequate to carry live loads.

502.03.22 Permanent Concrete Barrier Rail. Concrete barrier rail of the type shown on the plans shall be constructed by either of the following methods provided satisfactory results are obtained. Combining cast-in-place and extruded barrier rail within a given "run" will not be permitted unless otherwise approved by the Engineer.

Concrete barrier rails shall present a smooth, uniform appearance in the final position and shall conform to the horizontal and vertical lines shown on the plans.

Construction methods shall conform to the following:

(a) Cast-in-Place. Concrete barrier rails constructed by casting-in-place shall conform to the provisions in this section of these specifications.

(b) Extrusion Method. Concrete barrier rails constructed by using an extrusion machine or other similar type equipment shall be of well compacted dense concrete and the exposed surfaces shall conform to the requirements in

this section of these specifications. The contractor may be required to furnish evidence of successful operation of the extrusion machine or other equipment prior to commencement of work.

The concrete shall be vibrated, rammed, tamped, or worked with suitable appliances until the concrete has been consolidated to the maximum practicable density, free of rock pockets, and snug against the pre-formed surfaces. In conjunction with said method of consolidation, the equipment shall be operated under sufficient uniform restraint to forward motion to produce the required consolidation.

The concrete shall be of such consistency that after extrusion it will maintain the shape of the barrier rail without support.

The grade for the top of the concrete barrier rail shall be indicated by an offset guideline set by the Contractor from survey marks established by the Engineer. The forming portion of the extrusion machine shall be readily adjustable horizontally and vertically during the forward motion of the machine to conform to the predetermined grade line. A grade line gage or pointer shall be attached to the machine in such a manner that a continual comparison can be made between the barrier rail being placed to the established grade line as indicated by the offset guide line.

Instead of the above method for maintaining the barrier rail grade, the extrusion machine may be operated on rails or forms set at a uniform depth below the predetermined finished top of the barrier grade, or on existing pavement or bridge decks.

Expansion joints will be required only at structures.

Expansion joints of the width shown on the plans may be constructed by sawing through the barrier section to its full depth. Insertion of joint filler will not be required.

When expansion joints are not constructed by sawing, the expansion joints shall be constructed as provided in these specifications.

If sawing or forming joints is performed before the concrete has hardened, the adjacent portions of the barrier rail shall be supported firmly with close fitting shields.

If the optional horizontal construction joint is used and the footing is poured immediately ahead of the extruded portion of the barrier rail, the required eight (8) inch dowels may be omitted provided the barrier is placed before the concrete in the footing has attained the initial set.

If extrusion methods of placement are used, the horizontal reinforcing bars shall be placed continuously.

502.03.23 Portable Precast Concrete Barrier Rail. When required in the contract documents or ordered by the Engineer, the Contractor shall provide portable precast concrete barrier rail for protection of the public, or the work. The portable precast concrete barrier rail shall be new construction or State-furnished if so specified.

If new portable precast concrete barrier rail is specified, all of the applicable requirements of the plans and these specifications shall apply to the construction of said barrier rail.

If State-furnished material is specified, material on hand will be made available to the Contractor at locations specified in the contract documents

and it shall be the Contractor's responsibility to obtain said material from storage.

In either case, all materials shall be removed and stockpiled at the locations specified in the contract documents when the portable precast concrete barrier rail is no longer required for public safety or guidance, or for protection of the work, and said portable precast concrete barrier rail shall remain or become the property of the State.

Portable precast concrete barrier rail shall not be anchored except at the terminal panel as shown on the plans.

A "fine surface finish" is not required on portable precast concrete barrier rail.

Portable precast concrete barrier rail shall be reflectorized by placement of a two (2) way reflector in the center of each barrier rail section and located on top of the rail. Color of the reflectors shall conform to the requirements of the MUTCD Manual.

"Rent portable precast concrete barrier rail" shall conform to the requirements of Section 625, "Construction Signs."

502.03.24 Precast Concrete Box Culverts. When provided in the special provisions, the Contractor shall have the option of furnishing precast reinforced concrete box culverts in lieu of the cast-in-place method.

When the precast option is permitted and selected for use, or when the precast method is mandatory as provided in the special provisions, this work shall consist of furnishing and installing square or rectangular shaped precast reinforced concrete boxes at locations shown on the plans or established by the Engineer and in accordance with the requirements of these specifications, and as shown on the plans.

Square or rectangular precast reinforced concrete boxes shall conform to the specifications of AASHTO Designation M259 or M273, as controlled by the amount of cover shown on the plans. Minor deviations from the design dimensions may be allowed in order to conform with manufacturing processes upon approval by the Engineer.

Complete working drawings for the precast concrete boxes shall be submitted for review and approved by the Engineer prior to the start of any work. Two (2) sets of all working drawings prepared specifically for the contract shall be submitted to the Engineer for review and approval. After approval, five (5) sets shall be submitted to the Engineer for use during construction. Working drawings shall not exceed twenty-eight (28) inches by forty-two (42) inches in size and each drawing shall include the jobsite name of the structure as shown on the contract plans, district-county-route, bridge number, contract number, contractor, and sub-contractor, if any.

The Contractor shall notify the Engineer in writing two (2) weeks in advance of performing casting operations.

Concrete boxes shall be carefully handled in loading, unloading, transporting, and laying.

No box shall be laid which is cracked, checked, spalled, or damaged, and all such sections of box shall be permanently removed from the work. Boxes which show defects due to handling shall be rejected at the site of installation regardless of prior acceptance.

Fine cracks and checks on the surface of the member which do not extend to the plane of the nearest reinforcement will not be cause for rejection unless they are numerous and extensive. Cracks which extend into the plane of the reinforcing steel but are acceptable otherwise, shall be repaired in an approved manner.

Small damaged or honeycombed areas, which are purely surface in nature, may be repaired. Excessive damage, honeycomb, or cracking will be subject to structural review. Repairs shall be sound, properly finished, and cured in conformance with the pertinent specifications. When fine cracks or hairchecks on the surface indicate poor curing practices, further production of precast boxes shall be discontinued until corrections are made and proper curing provided.

The boxes shall be bedded as shown on the plans.

The placing of the boxes shall begin at the downstream end of the line. The grooved ends of the box segments shall be placed facing upstream. The bottom of the segments shall be in full contact with the prepared bedding. The box segments shall be checked for alignment and grade at the time of joining the sections.

The interior of the boxes shall be kept free of dirt and other foreign material as the box laying progresses, and left clean at the completion of the work. Any box which is not in true alignment or which shows any undue settlement after laying, or is damaged, shall be taken up and relaid at the Contractor's expense.

The box segments shall be jointed in such a manner that the ends are fully entered and the inner surfaces are flush and even. The maximum tolerable gap in the joints will be three-fourths (3/4) inch, checked immediately after making each joint. If, after the gap has been found to be within tolerances, an annular space still exists in the interior portion of the joint, the annular space shall be filled with an approved mortar. The mortar shall be finished flush with the interior surfaces of the box units.

Joints for precast boxes shall be sealed with flexible, watertight, preformed joint material installed according to the manufacturer's recommendations. Joint material shall conform to the requirements of AASHTO Designation M198, Type B.

For multiple box installations, a space of three (3) inches shall separate each line of boxes. The space between the box lines shall be filled solidly with grout. The grout shall be a workable mix suitable for pumping without segregation and shall be thoroughly mixed. The grout shall be placed by pumping or an approved alternate method. The grout shall be consolidated by mechanical vibration or rodding during placing. The grouting shall be done in a continuous pour in lifts not exceeding six (6) feet. Vertical grout barriers may be used to control the flow of grout horizontally. The grout shall attain a minimum compressive strength of two thousand five hundred (2,500) pounds per square inch in twenty-eight (28) days when tested in accordance with Test Method No. Nev. T475.

METHOD OF MEASUREMENT

502.04.01 Measurement. The estimated quantity shown on the plans, plus or minus quantities covered by approved changes, will be the quantity

used for payment. The Engineer or the Contractor may, however, request final measurement. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans, plus or minus approved changes, and quantities derived therefrom will be the quantity used for payment. Each class of concrete will be considered separately.

The estimated quantities shown on the plans for reinforced concrete box culverts are based upon dimensions required for cast-in-place construction. There shall be no adjustment of quantities due to the use of the precast method regardless of said method being optional or mandatory.

Such box culverts, bridges, and such other miscellaneous concrete structures that are identified on the plans or in the special provisions as major structures will be paid for at the contract unit price bid for "Class ..... Concrete (Major)," or "Class ..... Concrete Modified (Major)," as the case may be.

Such pipe headwalls, endwalls, drop inlets, and such other miscellaneous concrete structures that are identified on the plans or in the special provisions as minor structures will be paid for at the contract unit price bid for "Class ..... Concrete (Minor)."

In the event any class of Portland cement concrete is placed and is shown by test to be below the specified twenty-eight (28) day compressive strength, a determination shall be made by the Engineer as to whether the concrete shall be removed and replaced or allowed to remain in place. This determination shall be based on an evaluation of the durability and other qualities of the concrete necessary to the integrity of the structure.

If, after review, the concrete is allowed to remain in place, it is agreed by the parties to the contract that the Department will deduct from money due, or to become due to the Contractor from the Department, a percentage of the unit bid price. This deduction shall be considered to be liquidated damages and shall be at a rate of three (3) percent of the contract unit bid price for each one (1) percent (rounded to the nearest one (1) percent) below ninety-five (95) percent of the twenty-eight (28) day compressive strength to a maximum of thirty (30) percent of the unit bid price, as set forth in the following example.

Percent of Specified 28-Day Compressive Strength	Examples		Liquidated Damage (Per Unit Bid Price)
100	3000	4500	0
95	2850	4275	0
94	2820	4230	3
93	2790	4185	6
92	2760	4140	9
91	2730	4095	12
90	2700	4050	15
89	2670	4005	18
88	2640	3960	21
87	2610	3915	24
86	2580	3870	27
85	2550	3825	30

The reduced price shall apply to all concrete represented by the strength tests below the specified minimum compressive strength.

When a compressive strength test falls below the specified twenty-eight (28)

day compressive strength, the Department may determine that an alternate strength test is required or the Contractor may request such test. When the Department determines that an alternate strength test is required, the Contractor will not be liable for the cost of such test. In case the Department has not determined that an alternate strength test is necessary and the Contractor elects to have an alternate strength test made, the Department will then make such a test; however, should this test fail to indicate that the twenty-eight (28) day compressive strength requirements have been met, the cost thereof shall be deducted from any money due or to become due the Contractor from the Department. The cost of all other alternate strength tests made at the Contractor's request shall be borne by the Contractor. The alternate strength test shall consist of obtaining and testing three (3) drilled core samples in accordance with Test Method No. Nev. T474. The test specimens will be taken at a single location approved by the Engineer, and shall be from the same area represented by the original strength test. The cores shall be obtained and the test performed by the Department. The test shall be accomplished as soon as possible after the twenty-eight (28) day compressive strength test.

The average compressive strength of the three (3) drilled core samples at the age tested shall be converted to a twenty-eight (28) day compressive strength as shown by Chart No. 1 in subsection 501.02.04. This calculated value shall be termed the "result of the core test." When the result of the core test validates the original twenty-eight (28) day strength test, the quality of the concrete shall be assessed on the basis of the original test. When the core test does not validate the twenty-eight (28) day strength, then the result of the core test shall be used to assess the quality of the concrete.

Concrete removed will not be paid for and the removal thereof will be at the Contractor's expense.

No measurements or other allowances will be made for work, material for forms, falsework, cofferdams, pumping, bracing, etc.

The quantity of concrete involved in fillets, scorings, and chamfers two (2) square inches or less in cross sectional area shall be neglected. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage, and weep holes. The volume of concrete displaced by pipes, conduits, ducts (except that no deduction shall be made for prestressing ducts), and forms for voids embedded in concrete that are in excess of two (2) square inches in cross sectional area shall be deducted. Deduction shall also be made for the volume of timber piles, concrete piles, and cast-in-place piles embedded in the concrete.

Each class of concrete will be considered separately, except where the Contractor elects to use either Class DA concrete in lieu of Class AA concrete or Class D concrete in lieu of Class A concrete, such Class DA concrete or Class D concrete shall be measured as Class AA concrete or Class A concrete.

Tremie seal concrete will be measured on the basis of batched volume placed.

The quantity of "fine surface finish" measured for payment will be the number of square yards calculated and shown on the plans, plus or minus quantities covered by approved changes. The Engineer or the Contractor may

request recalculation if a possible error is suspected in the quantities shown on the plans.

Compression joint seal shall be measured for payment on a linear foot basis.

The work of repairing concrete bridge decks shall be measured for payment on a force account basis in accordance with subsection 109.03 of these specifications. Payment on a force account basis shall cease when bridge deck repair has been completed as approved by the Engineer.

The quantity of permanent or portable precast concrete barrier rail to be measured for payment will be the number of linear feet installed complete and in place.

Concrete barrier rail shall be measured for payment one (1) time only and movement of the portable barrier rail from one (1) location to another shall be considered necessary and essential and shall not constitute grounds for remeasurement. Should additional lengths of portable barrier rail be required above the length first measured, said additional lengths will be measured for payment.

The quantity of steel deck drain to be measured for payment will be the number of pounds of steel deck drain and pipe complete and in place within the structure, measured as provided in Section 506, "Steel Structures."

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

502.05.01 Payment. The accepted quantity of concrete measured as provided in subsection 502.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard for the class or type specified. Reinforcing steel will be paid for as provided in Section 505, "Reinforcing Steel." All metal parts, fabrics, pads, joint filler, and any other materials not specifically mentioned for payment herein, will be considered subsidiary to the other pay items of the work and no further compensation will be allowed therefor.

The accepted quantity of "fine surface finish" measured as provided above shall be paid for at the contract unit price bid per square yard which price shall be considered full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work as shown on the plans, specified herein, and as directed by the Engineer.

There shall be no direct payment for other types of finishing or for grooving the concrete surface with tines and all work involved shall be considered included in the contract bid prices for other items of work.

The accepted quantity of "compression joint seal," measured as provided above, shall be paid for at the contract unit price bid per linear foot which price shall be considered full compensation for labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work as shown on the plans and as approved by the Engineer.

Payment for concrete bridge deck repair, measured as provided above, will be paid for by force account.

Steel deck drains measured as provided in subsection 502.04.01, "Measurement," will be paid for as "structural steel" as set forth in Section 506, "Steel Structures."

The accepted quantity of concrete barrier rail, measured as provided in subsection 502.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the type of concrete barrier rail indicated in the proposal, which price shall be considered full compensation for furnishing all materials, labor, tools, supplies, equipment, reflective pavement markers, and incidentals necessary to construct the concrete barrier rail complete in place, including the base slab where required on the plans, excavation, backfill, all handling and transporting of portable barrier rail and all finishing (except "fine surface finish" when required) as shown on the plans or as specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Class ..... Concrete (Major)	Cubic Yard
Class ..... Concrete (Minor)	Cubic Yard
Class ..... Concrete, Modified (Major)	Cubic Yard
Tremie Seal Concrete	Cubic Yard
Fine Surface Finish	Square Yard
Concrete Barrier Rail (type)	Linear Foot
Portable Precast Concrete Barrier Rail	Linear Foot
Portable Precast Concrete Barrier Rail (State-Furnished)	Linear Foot
Compression Joint Seal	Linear Foot
Concrete Bridge Deck Repair	Force Account

SECTION 503

PRECAST PRESTRESSED CONCRETE MEMBERS

DESCRIPTION

503.01.01 General. This work shall consist of prestressing (a) precast concrete members, or (b) cast-in-place concrete members, by furnishing, placing, and tensioning prestressing steel in accordance with details shown on the plans, and as specified herein. The term "member" as used in this section shall be considered to mean the concrete which is to be or has been prestressed.

(a) Precast Concrete Members. This work shall consist of furnishing and placing either precast reinforced concrete members or precast prestressed concrete members, whichever is indicated on the plans.

Precast reinforced concrete members shall conform to the requirements of these specifications and the contract plans. At the Contractor's option, he may furnish and place precast prestressed concrete members in place of the precast reinforced concrete members. If a precast prestressed option is not shown, the dimensions shall be the same as shown on the plans for the precast reinforced concrete members.

Precast prestressed concrete members shall conform to the dimensions shown on the plans and shall be furnished complete including all concrete, prestressing steel, and items appurtenant to the prestressing method used, bar reinforcing steel and incidental materials in connection therewith, and also include the manufacture, transportation, storage, and placing of the member (girders, slabs, piling, and other structural members) except that piling shall be placed as provided in Section 508, "Piling."

This work shall also include furnishing and placing grout in shear keys and to fill dowel holes as shown on the plans.

(b) Cast-in-Place Concrete Members. This work shall include the furnishing and installation of any appurtenant items necessary for the particular prestressing system to be used, including but not limited to ducts, anchorage assemblies, and grout used for pressure grouting ducts.

MATERIALS

503.02.01 General. Concrete shall conform to the applicable requirements of Section 501, "Portland Cement Concrete," and Section 502, "Concrete Structures." Reinforcing steel shall conform to the applicable requirements of Section 505, "Reinforcing Steel." Prestressing steel shall conform to the applicable requirements of Section 713, "Reinforcement."

When concrete in precast or precast prestressed concrete members fails to meet the specified twenty-eight (28) day compressive strength, liquidated damages will be assessed or the concrete will be rejected, all in accordance with Sections 501 and 502 of these specifications. For the purpose of determining the amount of liquidated damages to be assessed, it shall be understood and agreed that the value of the concrete in a given member shall be

assumed to be equal to fifty (50) percent of the contract unit price bid per unit for the member(s).

CONSTRUCTION

503.03.01 General. Prestressing shall be performed by either (a) pretensioning methods, or (b) post-tensioning methods. The method of prestressing to be used shall be optional with the Contractor, subject to the requirements specified in these specifications. If the plans show details for only one (1) particular method, the use of the alternate method will be allowed only upon approval of the Engineer. If approval for the use of the alternate method is received, the Contractor shall then submit complete details and design calculations for the alternate and for any other necessary modifications to the member to the Engineer for approval. Work shall not commence until approval is granted in writing.

The Contractor shall submit working drawings to the Engineer for approval giving complete details and substantiating calculations of the method, materials, and equipment he proposes to use in the construction, prestressing, and/or erection operations. Such details shall outline the method of prestressing, and shall include the arrangement of the prestressing steel and mild steel reinforcement in the member, any additions or rearrangement of reinforcing steel, any revision in concrete dimensions from that shown on the plans, and working stresses. For the post-tensioning method the specifications and details of anchoring devices and distribution plates or assemblies, anchoring stresses, type of post-tensioning enclosures, sequence of stressing prestressing steel, pressure grouting materials and equipment, and a method of detensioning the prestressing steel should it become necessary to do so before grouting takes place shall also be included on the working drawings. For the pretensioning method the sequence of cutting or releasing the prestressing steel shall be included on the working drawings. The Contractor shall not cast any member to be prestressed before review of the working drawings is complete.

Precast Concrete Members. Drawings of the forms proposed for the precast members shall be submitted. Such drawings shall show complete details of the type of forms proposed for providing any indicated openings and proposed method of supporting and anchoring such forms.

In the event the Contractor elects to prestress precast concrete members and a prestressed option is not shown on the plans, the Contractor shall be required to design the members as precast prestressed members and shall submit three (3) copies of the longhand design and stress calculations to the Engineer for review and approval. Said design and stress calculations shall be submitted a minimum of four (4) weeks prior to casting members.

Three (3) sets of all working drawings prepared specifically for the contract shall be submitted to the Engineer for review and approval. After approval, five (5) sets shall be submitted to the Engineer for use during construction. Working drawings shall not exceed twenty-eight (28) inches by forty-two (42) inches in size and each drawing shall include the jobsite name of the structure as shown on the contract plans, district-county-route, bridge number, contract number, Contractor, and subcontractor if any.

At the completion of the contract, one (1) set of either (a) ink tracings on

cloth, (b) ink tracings on polyester base drafting film, (c) silver sensitized cloth duplicate tracings, or (d) silver sensitized polyester based reproduction films with matte surface on both sides, of all working drawings for railroad bridges shall be furnished and delivered to the Engineer by the Contractor at his expense.

The Contractor shall notify the Engineer in writing two (2) weeks in advance of performing prestressing operations.

503.03.02 Protection of Materials. All prestressing steel shall be protected against physical damage and rust or other results of corrosion at all times from manufacture to grouting or encasing in concrete. Prestressing steel that has sustained physical damage at any time shall be rejected. The development of visible rust or other results of corrosion shall be cause for rejection, when ordered by the Engineer.

Prestressing steel shall be packaged in containers or shipping forms for the protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor which prevents rust or other results of corrosion shall be placed in the package or form, or shall be incorporated in a corrosion inhibitor carrier type packaging material, or when permitted by the Engineer, may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Packaging or forms damaged from any cause shall be immediately replaced or restored to original condition.

The shipping package or form shall be clearly marked with a statement that the package contains high-strength prestressing steel, the care to be used in handling, and the type, kind, and amount of corrosion inhibitor used, including the date when placed, safety orders, and instruction for use.

No welds or grounds for welding equipment shall be made on the forms or on the steel in the member after the prestressing steel has been installed.

Any time acceptable prestressing steel for pretensioning is placed in the stressing bed and is exposed to the elements for more than thirty-six (36) hours prior to encasement in concrete, adequate measures shall be taken by the Contractor, as approved by the Engineer, to protect said steel from contamination or corrosion.

Prestressing steel for post-tensioning which is installed in members prior to placing and curing of the concrete, shall be continuously protected against rust or other corrosion, until grouted, by means of a corrosion inhibitor placed in the ducts or applied to the steel in the duct. The corrosion inhibitor shall conform to the requirements specified above.

The Contractor shall submit the following for the corrosion inhibitor: brand name, a sample, a list of chemicals and their proportions, and instructions for use.

When acceptable prestressing steel for post-tensioning is installed in the ducts after completion of concrete curing, and if stressing and grouting are completed within ten (10) calendar days after the protective packaging has been opened, rust which may form during said ten (10) days will not be cause for rejection of the steel. Prestressing steel installed, tensioned, and grouted in this manner, all within ten (10) calendar days, will not require the use of a

corrosion inhibitor in the duct following installation of the prestressing steel except when requested by the Engineer because of adverse weather conditions. Prestressing steel installed as above but not grouted within ten (10) calendar days shall be subject to all the requirements in this section pertaining to corrosion protection and rejection because of rust.

When steam curing is used, prestressing steel for post-tensioning shall not be installed until the steam curing is completed.

All water used for flushing ducts shall contain either quick lime (calcium oxide) or slaked lime (calcium hydroxide) in the amount of one-tenth (0.1) pound per gallon. All compressed air used to blow out ducts shall be oil free.

503.03.03 Forms. Concrete shall not be deposited in the forms until the Engineer has inspected the placing of the reinforcement, anchorages, any enclosures, and/or prestressing steel.

The concrete shall be vibrated internally or externally or both, as required to consolidate the concrete. The vibrations shall be done with care and in such a manner that displacement of reinforcement, enclosures, and/or prestressing steel will be avoided.

Forms for interior cells or holes in the members shall be constructed of a material that will resist breakage or deformation during the placing of concrete and will not materially increase the weight of the member. "Lost forms," left in place in interior cells, shall not exceed twelve (12) pounds per square foot of supported deck area.

Side forms for prestressed members may be removed the next day after placing concrete therein, provided arrangements satisfactory to the Engineer are made for curing and protecting the concrete. All side forms shall be removed prior to releasing pretensioned prestressing steel and prior to tensioning post-tensioned prestressing steel.

For precast members, holes for anchor bars, and for diaphragm dowels which pass through the member, openings for connection rods, recesses for grout, and any other holes and recesses as necessary shall be provided in the members in accordance with the details shown on the plans. Where diaphragm dowels do not pass through the member, the dowels may be anchored in the member by embedment in the concrete or by means of an approved threaded insert.

Lifting anchors may be installed in members to be placed in bridge decks provided that all of the anchor above the concrete is removed after the member is placed.

503.03.04 Anchorages and Distribution. All post-tensioned prestressing steel shall be secured at the ends by means of approved permanent type anchoring devices.

All anchorage devices for post-tensioning shall hold the prestressing steel at a load producing a stress of not less than ninety-five (95) percent of the specified ultimate tensile strength of the prestressing steel.

When headed wires are used, the outside edge of any hole for prestressing wire through a stressing washer or through an unthreaded bearing ring or plate

shall not be less than one-fourth (1/4) inch from the root of the thread of the washer or from the edge of the ring or plate.

The load from the anchoring device shall be distributed to the concrete by means of approved devices that will effectively distribute the load to the concrete. Such approved devices shall conform to the following requirements:

(a) The final unit compressive stress on the concrete directly underneath the plate or assembly shall not exceed three thousand (3,000) pounds per square inch.

(b) Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed the yield point of the material or cause visible distortion in the anchorage plate when ninety-five (95) percent of the specified ultimate tensile strength of the tendons is applied as determined by the Engineer.

(c) Materials and workmanship shall conform to the requirements in Section 506, "Steel Structures."

Should the Contractor elect to furnish anchoring devices of a type which are sufficiently large and which are used in conjunction with a steel grillage embedded in the concrete that effectively distributes the compressive stresses to the concrete, the steel distribution plates or assemblies may be omitted.

If loop tendon anchorages are used, they shall be enclosed in ducts for their entire length.

Where the end of a post-tensioned assembly will not be covered by concrete, the anchoring devices shall be recessed so that the ends of the prestressing steel and all parts of the anchoring devices will be at least two (2) inches inside of the end surfaces of the members, unless a greater embedment is shown on the plans. Following post-tensioning, the recesses shall be filled with concrete conforming to the requirements for the structure and finished flush.

503.03.05 Ducts. Duct enclosures for prestressing steel shall be rigid galvanized ferrous metal, mortar-tight, and accurately placed at the locations shown on the plans or approved by the Engineer.

All ducts or anchorage assemblies shall be provided with pipes or other suitable connections for injection of grout after prestressing.

Ducts for prestressing steel made up of a single wire, bar, or strand shall have a minimum inside diameter three-eighths (3/8) inch larger than the diameter of the wire, bar, or strand to be used. For tendons made up of a plurality of wires, bars, or strands, the duct area shall be at least twice the gross area of the prestressing steel.

Ducts for prestressing steel shall be securely fastened in place to prevent movement.

After installation in the forms, the ends of the ducts shall at all times be covered as necessary to prevent the entry of water or debris. If prestressing steel is to be installed after the concrete has been placed, the duct shall be blown out or flushed and blown out immediately prior to installation of the steel. The Contractor shall demonstrate to the satisfaction of the Engineer that the ducts are free of water and debris immediately prior to installation of the steel.

Rigid ducts may be fabricated with either welded or interlocked seams. Galvanizing of the welded seam will not be required. Rigid ducts shall have sufficient strength to maintain their correct alignment during placing of concrete. Joints between sections of rigid duct shall be positive metallic connections which do not result in angle changes of the joints. Waterproof tape shall be used at the connections. Ducts shall be bent without crimping or flattening. Transition couplings connecting said ducts to anchoring devices need not be galvanized.

(a) Precast Members. In lieu of metallic enclosures, openings for prestressing steel may be formed by means of cores or ducts composed of rubber or other suitable materials which are removed prior to installing prestressing steel.

(b) Cast-in-Place Concrete Members. All ducts for continuous structures shall be vented within three (3) feet of the high points of the cable path. Vents shall be one-half (½) inch minimum diameter standard pipe. Connections to ducts shall be made with metallic structural fasteners. The vents shall be mortar-tight, taped as necessary, and shall provide means for injection of grout through the vents and for sealing the vents. End of vents shall be removed one (1) inch below the top of the top slab after grouting has been completed.

503.03.06 Prestressing. All prestressing steel shall be tensioned by means of hydraulic jacks so that the force in the prestressing steel shall not be less than the value shown on the plans.

Unless otherwise specified or shown on the plans, the average working stress in the prestressing steel shall not exceed sixty (60) percent of the specified minimum ultimate tensile strength of the prestressing steel. The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed seventy-five (75) percent of the specified minimum ultimate tensile strength of the prestressing steel. The prestressing steel shall be anchored at stresses (initial stress) that will result in the ultimate retention of working forces of not less than those shown on the plans, but in no case shall the initial stress exceed seventy (70) percent of the specified minimum ultimate tensile strength of the prestressing steel.

Working force and working stress will be considered as the force and stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, creep of steel, losses in post-tensioned prestressing steel due to sequence of stressing, friction and take up of anchorages, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

The loss in stress in post-tensioned or pretensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, sequence of stressing, and elastic compression of concrete shall be as indicated on the plans. Losses peculiar to the chosen method or system of prestressing such as sequence of stressing or friction and take up of anchorage shall be determined by the prestressor and included in his submittal of substantiating calculations for review.

Each jack used to stress tendons shall be equipped with either a pressure gage or a load cell for determining the jacking stress, at the option of the Contractor. The pressure gage, if used, shall have an accurately reading dial at least six (6) inches in diameter and each jack and its gage shall be calibrated as a unit with the cylinder extension in the approximate position that it will be at final jacking force, and shall be accompanied by a certified calibration chart. The load cell, if used, shall be calibrated and shall be provided with an indicator by means of which the prestressing force in the tendon may be determined. The range of the load cell shall be such that the lower ten (10) percent of the manufacturer's rated capacity will not be used in determining the jacking stress.

The certified calibration charts for the hydraulic jacks, pressure gages, or load cells used for tensioning prestressing steel may be checked before and during tensioning operations with state-furnished load cells. The Contractor shall provide, at his expense, sufficient labor, equipment, and material to install and support the load cells at the prestressing tendons and to remove the load cells after the checking is complete, as ordered by the Engineer. The checking operations, except as provided in this paragraph, will be conducted by state forces.

The tensioning of prestressing steel in any post-tensioned member and the cutting or releasing of prestressing steel in any pretensioned member shall not be performed until tests on concrete cylinders made of the same concrete and cured under conditions identical to the member has attained the minimum compressive strength value specified for stressing or releasing of the steel.

(a) Pretensioning Method. When ordered by the Engineer, prestressing steel tendons in pretensioned members, if tensioned individually, shall be checked by the Contractor for loss of prestress not more than three (3) hours prior to placing concrete for the members. The method and equipment for checking the loss of prestress shall be subject to approval by the Engineer. All tendons which show a loss of prestress in excess of three (3) percent shall be retensioned to the original computed jacking stress.

When prestressing steel in pretensioned members is tensioned at a temperature appreciably lower than the estimated temperature of the concrete and the prestressing steel at the time of initial set of the concrete, the calculated elongation of the prestressing steel shall be increased to compensate for the loss in stress, but in no case shall the jacking stress exceed seventy-five (75) percent of the specified minimum ultimate tensile strength of the prestressing steel.

The cutting and releasing of prestressing steel in pretensioned members shall be performed in such an order that lateral eccentricity of prestress will be a minimum. The prestressing steel shall be cut flush with the end of the member and the exposed ends of the prestressing steel shall be heavily coated with roofing asphalt, coal tar enamel, zinc-rich paint, or lead-rich paint at the Contractor's option.

(b) Post-Tensioning Method. The following formula and friction coefficients shall be used in calculating friction losses in tendons:

$$T_o = T_x e^{(Ua+Kl)}$$

Where: T_o = Steel stress at jacking end
T_x = Steel stress at any point x
e = Base of Naperian Logarithms
U = Friction curvature coefficient
a = Total angular change of prestressing steel profile in radians from jacking end to point x
K = Friction wobble coefficient
l = Length of prestressing steel from jacking end to point x

Type of Steel	Type of Duct	K	U
Wire or strand	Galvanized-rigid	0.0002	0.25
Plain bars	Galvanized	0.0002	0.15
Deformed bars	Galvanized	0.0003	0.30

Prior to placing forms for closing slabs of box girder cells, the Contractor shall demonstrate to the satisfaction of the Engineer that either the prestressing steel is free and unbonded in the duct or, if prestressing steel has not yet been placed, that all ducts are unobstructed.

Prior to post-tensioning any member, the Contractor shall demonstrate to the satisfaction of the Engineer that the prestressing steel is free and unbonded in the duct.

Except as herein provided, cast-in-place and precast concrete shall not be post-tensioned until at least ten (10) days after the last concrete has been placed in the member to be prestressed and until the compressive strength of said last placed concrete has reached the strength specified for the concrete at the time of stressing. At the Contractor's option, with approval from the Engineer, up to fifty (50) percent of the total prestressing force may be applied prior to the ten (10) day limitation mentioned above provided the concrete has reached the compressive strength equal to the strength at the time of initial prestressing shown on the plans.

The tensioning process as applied to post-tensioned members shall be so conducted that tension being applied and the elongation of the prestressing steel may be measured at all times. A record shall be kept of gage pressures and elongations at all times and shall be submitted to the Engineer for approval.

Prestressing tendons in continuous post-tensioned members shall be tensioned by jacking at each end of the tendon. Such jacking of both ends need not be done simultaneously. Where one (1) end stressing is shown on the plans, tensioning of such tendons shall be done by jacking from one (1) end only or, when indicated on the plans, half of the prestressing steel shall be tensioned from one (1) end of the member and the other half from the opposite end.

Deviations of the above may be made upon review and approval of the Engineer.

Prestressing tendons in simple span post-tensioned members may be tensioned by jacking from one (1) end only. When tensioning is done from one (1) end only, half of the prestressing steel in each member shall be tensioned

from one (1) end of the member and the other half from the opposite end unless otherwise permitted by the Engineer.

After precast post-tensioned members have been grouted as hereinafter specified, the members shall not be moved or otherwise disturbed for a period of twenty-four (24) hours. However, when cold weather conditions prevail, the members shall not be moved or disturbed for a period of forty-eight (48) hours as outlined in subsection 503.03.08, "Bonding and Grouting."

For post-tensioning of cast-in-place members, the allowable variation of the force between girders shall be in the ratio of three (3) to two (2). However, the maximum force variation between girders shall not exceed seven hundred fifty (750) kips. The force shall be computed assuming the stress in the strand is six-tenths (0.6) f's.

503.03.07 Curing. Curing shall conform to the applicable provisions of subsection 501.03.09, "Curing," or by steam curing, at the option of the Contractor. Steam curing for members shall conform to the following provisions:

(a) The initial application of the steam shall be from two (2) to four (4) hours after the final placement of concrete to allow the initial set of the concrete to take place. If retarders are used, the waiting period before application of the steam shall be from four (4) to six (6) hours. If the ambient air temperature is below fifty (50) degrees F. steam shall be applied during the presteaming period to hold the air surrounding the member at a temperature between fifty (50) degrees and ninety (90) degrees F.

(b) To prevent moisture loss on exposed surfaces during the presteaming period, members shall be covered as soon as possible after casting or the exposed surfaces shall be kept wet by fog spray or wet blankets.

(c) Enclosures for steam curing shall allow free circulation of steam about the member and shall be constructed to contain the live steam with a minimum heat and moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good repair and secured in such a manner to prevent the loss of heat, steam, and moisture.

(d) The steam shall be at one hundred (100) percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Steam jets shall not impinge directly on the concrete, test cylinders, or forms. During application of the steam the ambient air temperature rise within the enclosure shall not exceed forty (40) degrees F. per hour until a maximum temperature of from one hundred forty (140) degrees to one hundred sixty (160) degrees F. is reached. The maximum temperature shall be held until the concrete has reached the desired strength. In discontinuing the steam, the ambient air temperature shall decrease at a rate not to exceed forty (40) degrees F. per hour until a temperature has been reached about twenty (20) degrees F. above the temperature of the air to which the concrete will be exposed. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where the temperature is representative of the average temperature of the enclosure.

(e) The concrete shall not be exposed to temperatures below freezing for six (6) days after casting.

503.03.08 Bonding and Grouting. (a) Grout for Post-Tensioning Ducts. Post-tensioned prestressing steel shall be bonded to the concrete by completely filling the entire void space between the duct and the tendon with grout.

Grout shall consist of Portland cement, water, and an expansive admixture approved by the Engineer. The Contractor shall be aware of any effects admixtures commonly used to provide expansion may have on the properties of the grout.

Portland cement shall be Type II "low-alkali" cement conforming to the requirements of Section 701, "Portland Cement." The use of pozzolan shall not be permitted.

Water shall comply with the requirements of Section 722, "Water."

The use of admixtures shall comply with the requirements of subsection 501.02.03, "Admixtures," except that the admixture shall not contain chloride ions in excess of twenty-five one-hundredths (0.25) percent by weight of admixture and the admixture may be dispensed in solid form.

Water shall be first added to the mixer followed by cement and admixtures.

The grout shall be mixed in mechanical mixing equipment of a type that will produce uniform and thoroughly mixed grout. The water content shall be not more than five (5) gallons per ninety-four (94) pound sack of cement. Retempering of grout will not be permitted. Grout shall be continuously agitated until it is pumped.

The pump-ability of the grout shall be determined by the Engineer in accordance with Test Method No. Nev. T426. The efflux time of a grout sample immediately after mixing shall be not less than eleven (11) seconds.

Grouting equipment shall be capable of grouting at a pressure of at least one hundred (100) pounds per square inch.

Grouting equipment shall be furnished with a pressure gage having a full-scale reading of not more than three hundred (300) pounds per square inch.

Standby flushing equipment capable of developing a pumping pressure of two hundred fifty (250) pounds per square inch and of sufficient capacity to flush out any partially grouted ducts shall be provided.

All ducts shall be clean and free of deleterious materials that would impair bonding of the grout or interfere with grouting procedures.

All grout shall pass through a screen with seven one-hundredths (0.07) inch maximum clear openings prior to being introduced into the grout pump.

When hot weather conditions would contribute to quick stiffening of the grout, the grout shall be cooled by approved methods as necessary to prevent blockages during pumping operations.

Grout injection pipes shall be fitted with positive mechanical shutoff valves. Vents and ejection pipes shall be fitted with valves, caps, or other devices capable of withstanding the pumping pressures. Valves and caps shall not be removed or opened until the grout has set. Leakage of grout through the anchorage assembly shall be prevented by positive mechanical means. Grout injection pipes shall be rigid galvanized ferrous metal, mortar-tight, and the use of polyvinyl chloride (PVC) pipe will not be allowed.

Grout shall be pumped through the duct and continuously wasted at the outlet until no visible slugs of water or air are ejected and the efflux time of ejected grout is not less than eleven (11) seconds. The outlet pipe shall then be

closed and the pumping pressure held momentarily. The valve at the inlet shall then be closed while maintaining this pressure.

When cold weather conditions prevail, the ducts shall be kept free of water to avoid damage due to freezing, and at the time of grouting, the surface temperature of the concrete in the member shall be forty-five (45) degrees F. or higher and maintained at or above this temperature for twenty-four (24) hours before and forty-eight (48) hours after grouting takes place. The temperature of the grout shall not exceed ninety (90) degrees F. during mixing or pumping.

The surface of concrete against which concrete encasement over anchorage assemblies is to be placed shall be abrasive blast cleaned and clean aggregate exposed after grouting of the ducts has been completed.

(b) Grout for Shear Keys and Dowel Holes. Grout for shear keys and dowel holes shall be composed of one (1) part by volume of cement to two (2) parts by volume of sand. The grout shall contain only enough water to permit placing and tamping.

Concrete areas to be in contact with the grout shall be cleaned of all loose or foreign material that would in any way prevent bond between the grout and the concrete surfaces. These areas shall be flushed with water and allowed to dry to a surface dry condition immediately prior to placing the grout.

Longitudinal keyways and other locations where grout could escape shall be mortar-tight before placing grout. The grout shall be thoroughly tamped into the openings. After placing, the grout shall be cured by the water method for a period of not less than three (3) days.

All improperly cured or otherwise defective grout shall be removed and replaced by the Contractor at his expense.

503.03.09 Handling of Precast Members. Extreme care shall be exercised in handling, storing, moving, and erecting precast concrete members to avoid twisting, racking, or other distortion that would result in cracking or damage to the members. Precast members shall be handled, transported, and erected in an upright position, and the points of support and directions of the reactions with respect to the member shall be approximately the same during transportation and storage as when the member is in its final position.

503.03.10 Tolerances for Precast Members. Precast prestressed concrete members shall be fabricated to plan dimensions within the tolerances listed herein (tolerances are not to be considered accumulative). Members having dimensions outside the tolerance limits shall be subject to rejection.

(a) Precast Prestressed Concrete I-Beams:

Depth (flanges, web, and fillets)	$\pm 1/4$ in.
Depth (overall)	$+1/2$ in. to $-1/4$ in.
Width (flanges and fillets)	$+3/8$ in. to $-1/4$ in.
Width (web)	$+3/8$ in. to $-1/4$ in.
Length of Beam	$\pm 1/8$ in. per 10 ft. or $1/2$ in. whichever is greater
Exposed beam ends deviation from square or designated skew	Horiz. $\pm 1/4$ in. Vertical $\pm 1/8$ in. per ft. of beam ht.

Side inserts (spacing between centers of inserts and from the centers of inserts to the ends of the beams)..... ±1/2 in.
Bearing Plates (spacing between the centers of bearing plates)..... ±1/8 in. per 10 ft. or 1/2 in. whichever is greater
Bearing Plate (spacing from the centers of bearing plates to the ends of the beams)..... ±1/2 in.
Bearing Plate or Bearing Area deviation from plane..... ±1/16 in.
Stirrup Bars—Projection above top of beam..... ±3/4 in.
Stirrup Bars—Longitudinal spacing..... ±1 in.
End Stirrup Bars—not more than 2 in. from the end of the beam
Horizontal Alignment (deviation from a straight line parallel to the centerline of beam)..... 1/8 in. per 10 ft.
Camber differential between adjacent beams..... 1/8 in. per 10 ft. of span to maximum of 1 in.
Center of gravity of strand group..... ±1/4 in.
Center of gravity of depressed strand group at end of beam..... ±1/2 in.
Position of post-tensioning duct..... ±1/4 in.
Position of hold-down points for depressed strands..... ±6 in.
Position of handling devices..... ±6 in.

(b) Precast Prestressed Concrete Box Beams and Flat Slabs:

Depth (top slab)..... ±1/2 in.
Depth (bottom slab)..... +2 in. to —0 in.
Depth (overall)..... ±1/4 in.
Width (web)..... ±3/8 in.
Width (overall)..... ±1/4 in.
Length..... ±1/8 in. per 10 ft. or 1/2 in. whichever is greater
±1/2 in. from end of void to center tie hole
Void Position..... ±1 in. adjacent to end block
Square Ends (deviation from square)..... ±1/4 in.
Skew Ends (deviation from designated skew)—
Skew angle equal to or less than 30 degrees..... ±1/4 in.
Skew angle greater than 30 degrees..... ±1/2 in.
Beam Seat Bearing Area (variation from plane surface when tested with a straight edge) through middle half of member..... ±1/16 in.
Horizontal Alignment (deviation from a straight line parallel to the centerline of member)..... 1/4 in. to 40 ft. lengths; 3/8 in. from 40 to 60 ft. lengths; 1/2 in. above 60 ft. lengths
Dowel Tubes (spacing between the centers of tubes and from the centers of tubes to the ends and sides of member)..... ±1/2 in.
Tie Rod Tubes (spacing between the centers of tubes and from the centers of tubes to the ends of the member)..... ±1/4 in.
Tie Rod Tubes (spacing from centers of tubes to the bottom of the beams)..... ±1/4 in.
Total width of Deck..... Theoretical width +1/2 in. per joint
Camber differential between adjacent units..... 1/2 in. max.
Camber differential between High and Low members in same span..... 1 in. max.
Side Inserts Positioning..... Same as for I-beams

Stirrup Bar Positioning	Same as for I-beams
Tendon Positioning	Same as for I-beams
Handling Device Positioning	Same as for I-beams

(c) Precast Prestressed Concrete Piling:

Width or Diameter	$-1/4$ in. to $+3/8$ in.
Head out of square	$1/16$ in. per 12 in. of width
Length of pile	$\pm 1\,1/2$ in.
Horizontal Alignment (deviation from a straight line parallel to the centerline of the pile)	$1/8$ in. per 10 ft.
Void location	$\pm 1/2$ in.
Stirrup Bars or Spiral Positioning	Same as for I-beams
Tendon Positioning	Same as for I-beams
Handling Device Positioning	Same as for I-beams

METHOD OF MEASUREMENT

503.04.01 Measurement. Measurement shall be made as follows:

(a) Precast Members. Precast concrete members (reinforced or prestressed) will be measured per each of the various sizes and types for furnishing and erecting precast concrete members complete and in place.

The length of the members shown in the estimate of quantities and/or in the proposal are nominal. For exact length see the drawings of the members shown on the plans.

(b) Cast-in-Place Members. The unit of measurement for prestressing cast-in-place concrete shall be lump sum.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

503.05.01 Payment. Payment shall be made as follows:

(a) Precast Members. The accepted quantities of precast concrete members (reinforced or prestressed) measured as provided in subsection 503.04.01, "Measurement," will be paid for at the contract unit prices bid for furnishing and erecting precast concrete members.

Payment therefor will be full compensation for all labor and for furnishing all items involved in the finished precast members.

NOTE: Should precast prestressed concrete members be furnished, at the option of the Contractor, in the place of precast reinforced concrete members, they shall be measured and paid for as though they were precast reinforced concrete members and no additional compensation will be allowed therefor.

The cost of furnishing and placing any additional concrete or bar reinforcing steel required by the particular system used, as well as ducts, anchoring devices, distribution plates or assemblies, and incidental parts, for furnishing samples for testing, for grouting recesses and pressure grouting ducts shall also be considered as included in the contract price for furnishing precast members, and no additional compensation will be allowed therefor.

Payment will be made under:

Pay Item	Pay Unit
(size) Precast Concrete Members	Each

(b) Cast-in-Place Members. The contract lump sum price paid for "prestressing cast-in-place concrete" shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all work involved in furnishing, placing, and tensioning the prestressing steel in cast-in-place concrete structures, complete in place, as shown on the plans, as specified in these specifications, and as directed by the Engineer.

Full compensation for furnishing and placing all concrete and reinforcing steel in the projecting portion of the bearing seats for prestressing anchorages shall be considered included in the contract lump sum price bid for prestressing cast-in-place concrete, and no additional compensation will be allowed therefor. The limits of the areas which are to be included in the lump sum price shall be as indicated on the plans. The cost of furnishing and placing any additional concrete or bar reinforcing steel required by the particular system used, as well as ducts, anchoring devices, distribution plates, or assemblies and incidental parts, for furnishing samples for testing, for grouting recesses and pressure grouting ducts shall also be considered as included in the contract lump sum price paid for prestressing cast-in-place concrete and no additional compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Prestressing Cast-in-Place Concrete	Lump Sum

SECTION 504

LIGHTWEIGHT CONCRETE FOR STRUCTURES

DESCRIPTION

504.01.01 General. This work shall consist of furnishing and placing lightweight Portland cement concrete in bridges, culverts, and other types of concrete structures. The construction of conventionally reinforced lightweight concrete structures shall conform to the requirements of Section 501, "Portland Cement Concrete," and Section 502, "Concrete Structures."

MATERIALS

504.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the requirements for such materials in the following sections:

Portland Cement Concrete	Section 501
Concrete Structures	Section 502
Aggregate for Portland Cement Products	Section 706

Lightweight concrete shall be composed of an intimate mixture of Portland cement, water, and lightweight aggregates, with or without natural sand of normal specific gravity, and an air entraining admixture proportioned and mixed as hereinafter provided.

504.02.02 Admixtures. Admixtures shall conform to the applicable requirements of subsection 501.02.03, "Admixtures."

504.02.03 Concrete Making Properties. Lightweight concrete shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Making Test Specimens (laboratory)	Nev. T455*	----------
Making Test Specimens (field)	Nev. T428	----------
Compressive Strength	Nev. T475	Table I
Unit Weight & Cement Factor (wet)	Nev. T435	Table I
Tests for Popouts	Nev. T462	No Surface Popouts
Freezing & Thawing	Nev. T465	----------
Air Content	Nev. T431	Table I
Slump	Nev. T438	Table I
Air Dried Weight	Nev. T458	Table I
Coring Concrete	Nev. T474	Sec. 504.04.01

*The compressive strength requirements of Portland cement concrete shall be based on the strength test, which is defined as the average of the breaking strength of three (3) standard cylinders at twenty-eight (28) days. The cylinder strengths shall be determined in accordance with Test Method No. Nev. T475.

A test, as defined above, will be required for each fifty (50) cubic yards, or portion thereof, placed each day. For large, continuous pours, one (1) test near the beginning of the pour, and one (1) test near the end of the pour may be substituted for the fifty (50) cubic yard requirement. In any case, there

shall be at least one (1) strength test made each day that concrete is placed, regardless of the volume placed. Other cylinders may be made and broken for information purposes.

CONSTRUCTION

504.03.01 General. Mixing water, storage of cement, measurement of materials, weighing and measuring equipment, condition of equipment, mixing conditions, and mixing equipment shall conform to the requirements of Section 501, "Portland Cement Concrete," and Section 502, "Concrete Structures."

The Contractor shall notify the Engineer not less than thirty-two (32) calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes. Samples will not exceed five hundred (500) pounds for each separate grading. The Contractor shall furnish a written statement giving the cement factor in sacks per cubic yard, the proportions of cement and each size of aggregate in a saturated surface dry condition, the slump, and the percentage of air in the concrete proposed for use in the work. If the Contractor proposes to use an admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement. The Engineer, after making such tests as he deems advisable, will either accept the proposed materials and proportions or suggest modifications needed for acceptance. After acceptance by the Engineer of batch proportions and materials, they shall not be altered during the course of the work except as found necessary to maintain yield, cement factor, and unit weight within specification requirements. In no case shall revised batch proportions result in concrete that contains an amount of total water per cubic yard greater than one hundred five (105) percent of that contained in concrete of the accepted proportions.

504.03.02 Storage of Aggregates. Storage of aggregates shall conform to the pertinent requirements of subsection 501.03.03, "Storage of Aggregates," except as noted below.

Lightweight aggregate shall be stockpiled on the job or at a central batching plant for a minimum time of twenty-four (24) hours prior to its use in the project.

Fine and course aggregates shall be stockpiled separately.

504.03.03 Classification and Proportions. Lightweight concrete shall be proportioned by weight, using the lightweight aggregates under test, such that the compressive strength requirements in Table I will be satisfied without falling below the minimum, or exceeding the maximum values given. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions.

Batches of lightweight concrete placed on the work shall not vary more than plus or minus three (3) pounds per cubic foot in unit weight from the design mix. The cement factor of any individual batch placed in the work shall not be more than fifteen one-hundredths (0.15) sack per cubic yard less nor more

TABLE I

Class	Sacks Cement Per Cu. Yd. Min.-Max.	Max. Water, Gal. per Sack Cement*	Min Compr. Str. (28 day) p.s.i.	Slump Range, Inches	Entrained Air Range, Percent	Unit Wt. Variation	Air Dried Weight, Max. Lbs./Cu. Ft.
LA	6.0–7.0	6.0	3,000	1–4	0	±3 lbs.	115
LAA	6.0–7.0	5.5	3,000	1–4	4–7	±3 lbs.	115
Modified LA or LAA	6.0–8.0	6.0	Specified on plans	1–4	4–7	±3 lbs.	115

*Based on aggregate in a saturated surface—dry condition.

than twenty-five one-hundredths (0.25) sack per cubic yard greater than the designated factor (sacks of cement per cubic yard). Aggregates shall be batched and reported to the Engineer by weight but the weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

At the option of the Contractor, natural fine aggregate may be substituted for lightweight fine aggregate provided such substitution does not result in producing concrete having a weight in excess of maximum.

504.03.04 Mixing. Lightweight aggregates in combination with natural sand, if used, shall be of such character that workable concrete of the properties specified herein will be obtained. Should premoistening be required, it shall be done uniformly at least twenty-four (24) hours in advance of batching.

The batch shall be so charged that three-fourths (¾) of the total mixing water and admixtures are introduced in the mixer in advance of the aggregates. The aggregates shall then be introduced and mixed for a minimum of forty-five (45) seconds. The amount of absorption by the aggregate will be the determining factor in mixing time. The cement and final water shall be added and mixing completed. The total mixing time for stationary mixers shall not be less than three (3) minutes. Minimum mixing for concrete mixed in trucks shall be one hundred (100) revolutions of the drum.

The drum on truck mixers shall be operated at high speed while charging it with aggregate. Cement shall be introduced into the mixing drum while it is rotating at slow speed. Immediately prior to discharge of the concrete, the drum shall be rotated at high speed for at least sixty (60) seconds.

METHOD OF MEASUREMENT

504.04.01 Measurement. The quantity of lightweight concrete to be measured for payment will be the number of cubic yards complete and in place. The estimated quantity shown on the plans, plus or minus quantities covered by change order, will be the quantity used for payment. The Engineer or the Contractor may, however, request a final measurement. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantities used for payment. Each class of lightweight concrete will be considered separately. Only those quantities complete and in place will be measured for payment.

In the event any class of Portland cement concrete is placed and is shown by test to be below the specified twenty-eight (28) day compressive strength, a determination shall be made by the Engineer as to whether the concrete shall be removed and replaced or allowed to remain in place. This determination shall be based on an evaluation of the durability and other qualities of the concrete necessary to the integrity of the structure. If, after review, the concrete is allowed to remain in place, it is agreed by the parties to the contract that the Department will deduct from money due, or to become due to the Contractor from the Department, a percentage of the unit bid price. This deduction shall be considered to be liquidated damages and shall be at a

rate of three (3) percent of the contract unit bid price for each one (1) percent (rounded to the nearest one (1) percent) below ninety-five (95) percent of the twenty-eight (28) day compressive strength to a maximum of thirty (30) percent of the unit bid price, as set forth in the following example.

Percent of Specified 28-Day Compressive Strength	Examples	Liquidated Damage (Per Unit Bid Price)
100	3000 — 4500	0
95	2850 — 4275	0
94	2820 — 4230	3
93	2790 — 4185	6
92	2760 — 4140	9
91	2730 — 4095	12
90	2700 — 4050	15
89	2670 — 4005	18
88	2640 — 3960	21
87	2610 — 3915	24
86	2580 — 3870	27
85	2550 — 3825	30

The reduced price shall apply to all concrete represented by the strength tests below the specified minimum compressive strength.

Concrete removal will not be paid for, and the removal thereof will be at the Contractor's expense.

When a compressive strength test falls below the specified twenty-eight (28) day compressive strength, the Department may determine that an alternate strength test is required or the Contractor may request such a test. When the Department determines that an alternate strength test is required, the Contractor will not be liable for the cost of such test. In case the Department has not determined that an alternate strength test is necessary and the Contractor elects to have an alternate strength test made, the Department will then make such a test; however, should this test fail to indicate that the twenty-eight (28) day compressive strength requirements have been met, the cost thereof shall be deducted from any money due or to become due the Contractor from the Department. The cost of all other alternate strength tests made at the Contractor's request shall be borne by the Contractor. The alternate strength test shall consist of obtaining and testing three (3) drilled core samples in accordance with Test Method No. Nev. T474. The test specimens will be taken at a single location approved by the Engineer, and shall be from the same area represented by the original strength test. The cores shall be obtained and the test performed by the Department. The test shall be accomplished as soon as possible after the twenty-eight (28) day compressive strength test.

The average compressive strength of the three (3) drilled core samples at the age tested shall be converted to a twenty-eight (28) day compressive strength as shown by Chart No. 1 in subsection 501.02.04, "Concrete Making Properties." This calculated value shall be termed the "result of the core test." When the result of the core test validates the original twenty-eight (28) day strength test, the quality of the concrete shall be assessed on the basis of the original test. When the core test does not validate the twenty-eight (28) day strength test, then the result of the core test shall be used to assess the quality of the concrete.

No measurement or other allowance will be made for work, material for forms, falsework, cofferdams, pumping, bracing, etc.

The quantity of concrete involved in fillets, scorings, and chamfers two (2) square inches or less in cross sectional area shall be neglected. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage and weep holes, pipes, conduits, and ducts embedded in concrete. Deduction shall be made for the volume of timber piles, concrete piles, and cast-in-place piles embedded in the concrete.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

504.05.01 Payment. The accepted quantity of concrete measured as provided in subsection 504.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard for the class of lightweight concrete specified. Reinforcing steel will be paid for as provided in Section 505, "Reinforcing Steel." All metal parts, fabrics, pads, joint filler, drains, and any other materials not specifically mentioned for payment herein, will be considered subsidiary to the other pay items of the work and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Class (.....) Lightweight Concrete	Cubic Yard

SECTION 505

REINFORCING STEEL

DESCRIPTION

505.01.01 General. This work shall consist of furnishing and placing reinforcing steel and mesh reinforcing in accordance with these specifications and in conformity with the plans.

This work shall also consist of furnishing and applying organic protective coatings on certain reinforcing steel bars as indicated on the plans, as well as the prequalification requirements for acceptance of the organic protective coatings. Tie wires used on bars which have the organic protective coating shall be coated with plastic or an equal type coating as approved by the Engineer.

At each end of each frame of the structure, the Contractor shall furnish and install two (2) No. 8 bare copper wires which shall be attached to the coated top slab reinforcing steel. Near one (1) end of the frame attach one (1) wire on the right side of the deck to a bar running parallel to the roadway centerline. On the left side of the deck attach one (1) wire to a bar running perpendicular to the roadway centerline. At the opposite end of the frame attach one (1) wire on the right side of the deck to a bar running perpendicular to the roadway centerline and on the left side of the deck attach a wire to a bar running parallel to the roadway centerline. All the above wires are to be extended to a minimum of three (3) inches beyond the outside of the structure. The wires are to be easily accessible to a person beside or under the structure without the aid of any equipment. It will be necessary to remove the organic coating prior to attaching the copper wires. The organic coating shall be replaced once the copper wires have been attached to the bars. The copper wires are not to come into contact with any metallic materials on their run to the outside of the structure.

MATERIALS

505.02.01 General. Materials shall conform to the requirements specified in the following subsections:

Fabricated Steel Bar or Rod Mats Reinforcement	Subsection 713.03.02
Bar Steel Reinforcement	Subsection 713.03.01
Welded Steel Wire Fabric Reinforcement	Subsection 713.03.03

All bar steel reinforcement may be either Grade 40 or Grade 60 unless otherwise specified on the plans.

Spiral reinforcement may be either bar steel reinforcement or steel wire, of the equivalent size of the bar steel.

The prequalification of organic coatings for steel reinforcing bars shall conform to AASHTO Designation M284 Annex A1 (ASTM Designation D3963 Annex A1).

The following products have met the prequalifications test for epoxy coat-

ings, and it is anticipated that no further prequalification will be required by these companies.

Corvel ECA-1558, Red-27000, Corvel ECA-1440, Green-3169—Manufactured by The Polymer Corporation, Reading, Pennsylvania.

Epoxiplate—R-346, R-347, R-348, R-349, R-350, R-352, R-361, and R-371—Manufactured by Armstrong Products Company, P.O. Box 657, Warsaw, Indiana 46580.

Epoxy powder 720-A-009—Manufactured by Cook Paint and Varnish Company, P.O. Box 389, Kansas City, Missouri.

Flintflex—531-6080, 531-6085, 531-6086—Manufactured by E. I. Dupont deNemour Company, Inc., 308 E. Lancaster Avenue, Wynnewood, Pennsylvania.

Miccron 650—Manufactured by Republic Steel Corporation.

Mobilox 1004-R-2—Manufactured by Mobil Chemical Company.

Nap-Gard 7-2000—Manufactured by NAPCO Corporation.

Scotch Kote—202, 213, and 214—Manufactured by Minnesota Mining and Manufacturing Company, Inc., 320 Shaw Road, South San Francisco, California.

EL-704-P-9, epoxy powder—Manufactured by Fuller-O'Brien, P.O. Box 469, Tualatin, Oregon 97062.

Hysol DK23-0679 (Green) and Hysol DK23-0602 (Brown)s—Manufactured by the Hysol Division of the Dexter Corporation, Olean, New York 14780.

Corflex CF 4650 (Green)—Manufactured by Carboline/Ferro Company, St. Louis, Missouri.

Interpon HD-33 Fusion Bond—Manufactured by International Paint, Houston, Texas.

Further information and addresses on the coating material producers may be obtained by contacting Construction Methods and Practices Branch Construction and Maintenance Division, Office of Highway Operations, Federal Highway Administration, Washington, D.C. 20590.

505.02.02 Samples. One (1) extra bar of each diameter shall be furnished per contract for each one hundred (100) tons or fraction thereof. This bar shall be from the longest bar of each size so that it, or a portion of it, can be used to replace any bar of that diameter which is selected to be used as a field sample. The field sample must be of sufficient length to provide for two (2) thirty (30) inch samples of each diameter. The extra bars shall be indicated on the fabricator's details.

505.02.03 Specifications for Coating Reinforcing Steel. Coating of reinforcing steel shall conform to AASHTO Designation M284 (ASTM Designation D3963).

Patching or repair material, compatible with the coating and inert in concrete, shall be made available by the coating manufacturer. The material must be suitable for making repairs of areas of the coating damaged during fabrication or handling in the field. Sheared ends and other cuts or exposed areas shall be patched promptly and before detrimental oxidation occurs.

Patching shall be done in accordance with the manufacturer's recommendations and to the prescribed thickness.

Damage to the coating during fabrication shall be repaired by the fabricator using patching material as specified in this subsection in accordance with procedures specified by the manufacturer of the material and to the prescribed thickness.

Patching will be required on straight areas of the rebar only if damage exceeds two (2) percent of the coated area within the total straight portion of the coated rebar. When coating repair is required, all damage shall be patched on straight areas of the rebar.

Patching will be required within each bent area of the rebar only if bond loss and damage exceed five (5) percent of the coated area within each bent area. When coating repair is required, all damage within each area shall be cleaned and patched, but each bent area may be treated individually. Hairline cracks without bond loss or other damage on fabrication bends need not be patched. Required patching shall be done as soon as possible and before visible oxidation appears. Patching shall be done at the fabricator's plant.

All systems for handling coated bars shall have padded contact areas for the bars wherever possible.

All bundling bands shall be padded and all bundles shall be lifted with a strong back, multiple supports, or a platform bridge so as to prevent bar to bar abrasion from sags in the bar bundle.

The bars or bundles shall not be dropped or dragged.

Coating repair will not be required if damage is less than three (3) percent of the coated area. Where repair is required, all damaged areas will be repaired as soon as possible after each span is placed.

CONSTRUCTION

505.03.01 Bending Diagrams. Before placing reinforcing steel, two (2) copies of a list of all reinforcing steel shall be furnished to the Engineer at the site for his use in administering the contract. Furnishing such lists to the Engineer shall not be construed to mean that the lists will be reviewed for accuracy. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing all bar reinforcing steel in accordance with the details shown on the plans and as specified.

505.03.02 Protection of Materials. Reinforcing steel shall be protected at all times from damage. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil, or other foreign substance. However, when steel has on its surface loose mill scale or dust which is easily removable, it may be cleaned by a satisfactory method, if approved by the Engineer.

505.03.03 Bending. Bar reinforcement shall be bent to the shapes shown on the plans. All bars shall be bent cold unless otherwise permitted. Bends shall be made in accordance with the ACI Detailing Manual for detailing reinforced concrete structures.

Bars partially imbedded in concrete shall not be field bent except as shown

on the plans or specifically permitted. Bars shall not be bent or straightened in a manner that will injure the material. After a reinforcing bar has been bent or straightened once, it shall not be subjected to further bending.

The Contractor shall submit a bending procedure to the Engineer for approval prior to field bending any bars. Bars which are injured or broken shall be spliced in accordance with subsection 505.03.05, "Splicing." The method of splicing shall be submitted to the Engineer for approval.

Field bending shall be done to the following minimum diameters unless smaller diameters are approved by the Engineer:

Bar Size	Min. Bending Dia. (Inches)
#4	3
#5	4
#6	5
#7	6
#8	8
Above #8	Bending and Straightening Not Recommended.

The bending shall be done with a smooth continuous application of force. If a hickey bar is used in straightening a bar, it shall be done by progressively moving the hickey bar around the bend.

505.03.04 Placing and Fastening. All bar reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of concrete. When the spacing of bars exceeds one (1) foot in either direction, all intersections shall be tied. When the spacing of bars is one (1) foot or less in both directions, alternate intersections shall be tied.

Distance from the vertical and horizontal forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Blocks used for holding reinforcing bars from contact with the forms or between layers of bars shall be precast mortar blocks of approved shape and dimensions and shall have a compressive strength of not less than three thousand (3,000) p.s.i. Metal chairs which are in contact with the exterior surface of the concrete shall be fabricated of either galvanized steel, or have the steel tips plastic coated to at least three-fourths (3/4) inch into the concrete, or be of stainless steel conforming to the requirements of ASTM A493 Type 430. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks will not be permitted. Reinforcement in any member shall be placed, and then inspected and approved by the Engineer, before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal required.

If mesh reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

505.03.05 Splicing. All reinforcement bars shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without written approval of the Engineer. Splices shall be staggered as far as possible. Splicing of reinforcing bars shall be

either by lapping, welding, or by mechanical butt splicing. Reinforcing bars numbers fourteen (14) and eighteen (18) shall not be spliced by lapping.

Lapped Splices. Splices made by lapping shall consist of placing the reinforcing bars in contact and wiring them together in such a manner as to maintain the alignment of the bars and to provide minimum clearances.

Lapped splices will not be permitted at locations where the concrete section is not sufficient to provide a minimum clear distance of two (2) inches between the splice and the nearest adjacent bar. The clearance to the surface of the concrete shall not be reduced.

The required length of lapped splices shall be as shown on the plans.

Sheets of mesh reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one (1) mesh in width.

Welded Splices. Welding of reinforcing steel shall be done only if detailed on the plans or if written approval is given by the Engineer. Welding shall conform to the current specifications, Structural Welding Code, Reinforcing Steel, AWS D1.4 of the American Welding Society.

A full welded splice shall have bars buffed and welded to develop in tension at least one hundred twenty-five (125) percent of the specified yield strength of the bar.

Mechanical Butt Splices. Mechanical butt splicing of reinforcing steel shall be done only if detailed on the plans or if written approval is given by the Engineer.

Mechanical butt splices may be either the threaded sleeve coupler type, the filler metal sleeve coupler type, or the swaged sleeve coupler type.

A full mechanical connection shall develop in tension or compression, as required, at least one hundred twenty-five (125) percent of the specified yield strength of the bar.

The mechanical connections used shall be of approved design. Approval by the Engineer will be based upon technical data, including test results, and other necessary proof of satisfactory performance submitted by the manufacturer. Approval will also be based upon the results of tests which the Engineer may wish to perform on sample splices and splice material furnished by the manufacturer.

All splicing procedures shall be in accordance with the manufacturer's recommendations. Splices shall be made using the manufacturer's standard equipment and other required accessories.

Ends of reinforcing bars to be spliced shall be cut nominally square.

Splice sleeves shall have a clear coverage of not less than one and three-fourths (1¾) inches measured from the surface of the concrete to the outside of the sleeve. Stirrups, ties, and other reinforcement shall be adjusted or relocated and additional reinforcement shall be placed if necessary to provide planned clear coverage to reinforcement.

The following splice guidelines shall be followed when field splicing is made by the use of welding or mechanical couplers:

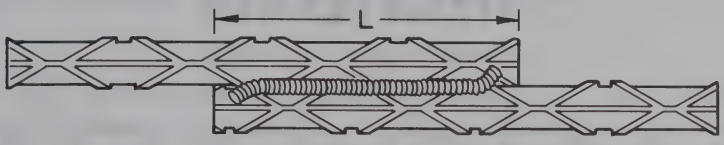
13

SPLICE GUIDELINES

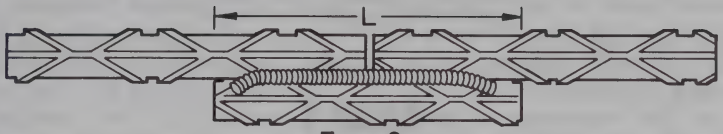
See "Splice Details" (Pages 341 and 342)	Process[7]	Electrode[7]	Bar Size
Single lap splice[1,5,6] Detail 1, Types 1a, 1b, 2a, 2b	SMAW	E9018	8 and smaller
	FCAW	GR. E90T	
Double lap splice Detail 2a, 2b[2,5,6]	SMAW	E9018	8 and smaller
	FCAW	GR. E90T	
100% penetration Butt weld—Detail 3a, 3b[3,5,6]	SMAW	E9018	4 through 18
	FCAW	GR. E90T	(see note No. 8)
75% penetration Butt weld with flare V groove lap splice—Detail 4[5,6]	SMAW	E9018	8 and smaller
	FCAW	GR. E90T	
GR. 40 to GR. 60[5,6]	SMAW	E7018	Any size with applicable notes for splice type.
	FCAW	GR. E70T-X	
Threaded sleeve coupler	.....	.....	Any size[4]
Filler metal sleeve coupler	.....	.....	Any size[4,9]
Swaged sleeve coupler	.....	.....	Any size[4,9]

[1]This detail not recommended for concrete coverage of less than three (3) inches.
[2]Welding both sides is unnecessary.
[3]When backup is not used, root should be backgouged before welding second side.
[4]Manufacturer's recommendations should be followed.
[5]Welder should have papers documenting his experience at welding rebar or be tested.
[6]Preheat weld spliced to six hundred (600) degrees F. and cool slowly (wrap with insulation) to two hundred (200) degrees F.
[7]SMAW and one-eighth (⅛) inch electrode are preferred.
[8]Smaller sizes are more difficult to butt weld.
[9]Larger sizes (10 and larger) have more difficulty in meeting requirements.

SPLICE DETAILS



Type 1



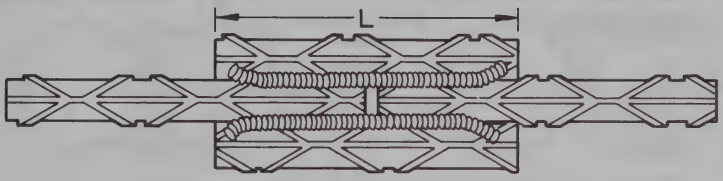
Type 2

BEGIN AND END WELD ON SPLICE BAR AS SHOWN

SINGLE LAP SPLICE WITH FLARE V GROOVE WELD

Detail 1

a. WELD ONE SIDE
b. WELD BOTH SIDES

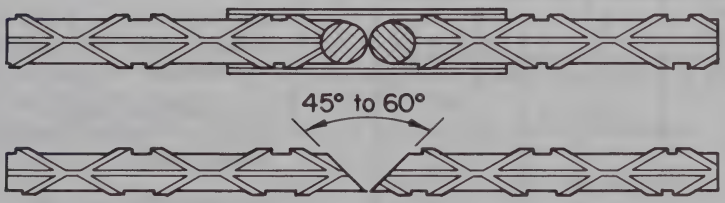


BEGIN AND END WELD ON SPLICE BAR AS SHOWN

DOUBLE LAP SPLICE WITH FLARE V GROOVE WELD

Detail 2

a. WELD ONE SIDE
b. WELD BOTH SIDES

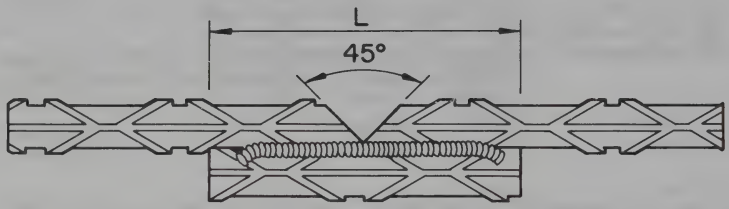


100% PENETRATION BUTT WELD

Detail 3

a. WITH SPLIT PIPE BACKING
b. NO BACK UP

SPLICE DETAILS

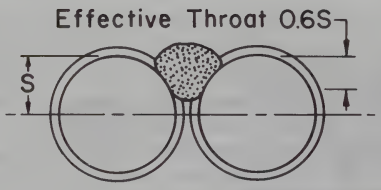


BEGIN AND END FLARE GROOVE WELD ON SPLICE BAR AS SHOWN

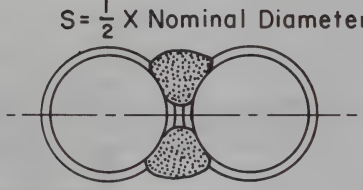
75% PENETRATION BUTT WELD WELD FLARE V GROOVE LAP SPLICE

Detail 4

A.W.S. VALUE FOR FLARE V GROOVE WELDS



1. FLARE V GROOVE WELDED ONE SIDE



2. FLARE V GROOVE WELDED BOTH SIDES

DIMENSIONS FOR WELD DETAILS			
BAR SIZE	ℓ^*	ℓ'	L
#4	1.31	3	4
#5	1.64	4	5
#6	1.96	5	6
#7	2.29	6	7
#8	2.62	7	8

* DOUBLE VALUES FOR DETAIL 1 TYPE 2.

ℓ = MINIMUM CALCULATED WELD LENGTH (INCHES) FOR BARS WELDED ON ONE SIDE.

ℓ' = RECOMMENDED WELD LENGTH (INCHES) FOR ALL CASES.

L = RECOMMENDED LAP OR SPLICE LENGTH (INCHES)

505.03.06 Substitutions. Substitution of different size bars will be permitted only with specific authorization by the Engineer. The bars substituted shall have an area equivalent to the design area or larger.

METHOD OF MEASUREMENT

505.04.01 Measurement. Bare reinforcing steel and coated reinforcing steel shall be measured for payment by the pound in accordance with this subsection and each type (bare or coated) shall be considered separately. No additional allowance will be made for the weight of the organic coating.

The calculated quantity shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment. The Engineer or the Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans, plus or minus approved changes, and quantities derived therefrom will be the quantity used for payment. The quantity of reinforcing steel measured for payment will be the number of pounds complete and in place.

The calculated weights of the plain and deformed bars shall be based on the following table:

Size No.	Nominal Diameter in Inches	Weight Per Foot in Pounds
2	0.250	0.167
3	0.375	0.376
4	0.500	0.668
5	0.625	1.043
6	0.750	1.502
7	0.875	2.044
8	1.000	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313
14	1.692	7.650
18	2.256	13.600

The quantity of mesh reinforcement to be measured for payment will be the number of square yards complete and in place measured along the plane of placement. No allowance will be made for laps.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

505.05.01 Payment. The accepted quantity of bare or coated reinforcing steel, measured as provided in subsection 505.04.01, "Measurement," shall be paid for at the contract unit price bid per pound for "reinforcing steel" or for "reinforcing steel (epoxy coated)," as the case may be, which price shall include full compensation for furnishing and installing reinforcing steel of the type specified (bare or epoxy coated) complete in place in the accepted work as shown on the plans and as directed by the Engineer. The cost of furnishing and installing bare copper wires, plastic coated tie wires and all costs involved

in coatings and touching up and repairing damaged coatings on bars shall not be paid for directly but the cost thereof shall be considered included in the contract unit price bid per pound for "reinforcing steel (epoxy coated)" and no further compensation shall be allowed therefor.

The accepted quantity of mesh reinforcement measured as provided in subsection 505.04.01, "Measurement," will be paid for at the contract unit price bid per square yard.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Reinforcing Steel	Pound
Reinforcing Steel (Epoxy Coated)	Pound
Mesh Reinforcing	Square Yard

SECTION 506

STEEL STRUCTURES

DESCRIPTION

506.01.01 General. This item shall consist of furnishing, fabricating, casting, machining, or otherwise preparing, transporting, erecting, and painting any or all structural steel, steel forgings, castings, deck drains, expansion joint armor, metal covers, sidewalk channels, and any other metal of the type, shape, dimensions, and quality required by these specifications or as shown on the plans.

506.01.02 AISC Certification. The fabricator of the structural steel shall be certified by the American Institute of Steel Construction's Quality Certification Program. The category of certification shall be as shown on the contract plans. The AISC certification shall be required for the fabrication of bridge structures only, but need not include the fabrication of deck drains, utility hangers, deck protection angles, pier nose angles or anchor bolt assemblies. Each fabricator shall submit to the Engineer a copy of the certification for the specified category, prior to or along with the first submittal of shop drawings.

MATERIALS

506.02.01 General. Materials shall conform to the pertinent requirements of the following sections:

Structural Steel	Section 710
Aluminum for Bridge Rail	Section 711
Miscellaneous Metals	Section 712
Paint	Section 714
Galvanizing	Section 715
Chain-Link Fabric	Section 724
Elastomeric Bearing Pads	Section 725

Unless otherwise shown on the plans, steel plates for main members and splice plates for flanges and main tension members shall be cut and fabricated so that the primary direction of rolling is parallel to the longitudinal axis of the member. Hinge hanger plates shall be cut and fabricated so the primary direction of rolling is perpendicular to the longitudinal axis of the member.

Welded sections may be substituted for the rolled shapes shown on the plans, provided that the shapes and sections to be substituted comply with the following provisions:

(a) The depth, width, and average thicknesses shall be at least equal to those for the shape or section shown on the plans.

(b) For welded sections, the flanges shall be welded to the web with continuous fillet welds on each side of the web, and the welding shall conform to the provisions in subsection 506.03.20, "Welding."

(c) The strength classification of the material shall not be reduced.

Anchor assemblies including anchor bolts, nuts, washers, plates, and pipes shall be galvanized after fabrication in accordance with Section 715, "Galvanizing."

506.02.02 Railing. Steel bridge rail shall be galvanized after fabrication and shall be painted white. Aluminum bridge rail shall not be painted. Steel pedestrian rail shall be galvanized after fabrication and shall not be painted.

Shims for steel railing shall be galvanized steel plates. Shims for aluminum railing shall be aluminum alloy.

Insulating material for insulating the bases of aluminum rail posts from concrete and from steel anchor bolts shall be an aluminum impregnated light colored caulking compound with the consistency of putty.

All bolts, nuts, and washers shall be either steel galvanized, stainless steel, or steel, cadmium plated in accordance with ASTM Designation A165, Type TS.

CONSTRUCTION

506.03.01 Shop Drawings. Shop drawings shall consist of shop detail erection and other working plans showing dimensions, sizes of material, details, and other information necessary for the complete fabrication and erection of the metal work. The drawings shall be prepared on sheets twenty-two (22) inches wide by thirty-six (36) inches. The original drawings may be made either on paper or on cloth but the details must be drawn so that the prints will be clear and legible.

Unless otherwise requested, the Contractor shall submit to the Engineer, 1263 South Stewart Street, Carson City, Nevada 89712, for his approval in accordance with the provisions of this subsection, shop drawings for structural steel. For initial review two (2) sets of such drawings shall be submitted for highway bridges. After initial review, between six (6) and twelve (12) sets, as requested by the Engineer, shall be submitted for final approval and for use during fabrication and construction. The Engineer reserves the right to refuse prints of shop drawings which are not clear and legible. All shop drawings shall be submitted for approval at least six (6) weeks before fabrication is started for highway bridges. No material shall be fabricated until the shop drawings have been approved by the Engineer and copies distributed. The shop drawings as approved by the Engineer shall become a part of the contract; provided, however, that any substitution of sections contemplated by the shop drawings different from sections shown on the plans shall be made only when approved by the Engineer and in such case, the additional costs resulting from such substitution shall be borne by the Contractor. After the fabrication and erection of the structural steel is complete, the Contractor shall furnish the Engineer the original tracings or reproducible negatives of all approved shop drawings, prior to final acceptance of the contract. See subsections 506.03.11, "Shop Assembly," and 506.03.26, "Erection Methods and Equipment," for additional requirements.

In the event the Contractor elects to furnish bridge rail constructed of aluminum as provided herein and the plan sheets show only steel bridge rail, the Contractor shall submit the fabricator's design calculations to the Engi-

neer in order that it may be verified that the railing and hardware conform to Section 1.1.9, "Railings," of the AASHTO Standard Specifications for Highway Bridges, current edition.

After approval there shall be no deviation from the shop drawings or changes made thereon without prior approval of the Engineer.

Approval of shop drawings shall be understood to be an acceptance of the character and sufficiency of the details and not a check of any dimensions. Checking shop drawings is intended as a means of facilitating the work and avoiding errors so far as possible, but it is expressly understood that it will not relieve the Contractor from the responsibility in regard to errors or omissions on said shop drawings.

The contract price shall include the cost of furnishing all shop drawings and the Contractor shall be allowed no extra compensation for such drawings.

506.03.02 Notice of Beginning Work. The Contractor shall give the Engineer fifteen (15) days written notice of manufacturing of material at the mill so that inspection may be provided. No material shall be manufactured or fabrication begun without authorization by the Engineer. The Engineer may inspect material, as provided for in ASTM Designation A6, at his option. Material not inspected at the place of manufacture shall be subject to inspection as provided for in subsection 506.03.03, "Inspection and Testing." "Mill" means any rolling mill or foundry where material for the work is to be manufactured.

Prior to the fabricator placing his order with the mill, he shall inquire with the Engineer if additional material will be required for testing. The additional material required for testing shall be at no additional cost to the Department.

Prior to the beginning of fabrication, a fifteen (15) day written notice shall be provided, by the Contractor, to the Engineer. Any purchase of material prior to inspection at the mill or fabrication of any work without authorization from the Engineer shall be at the Contractor's risk.

506.03.03 Inspection and Testing. The Engineer will examine and test as necessary all material before fabrication. Adequate facilities and free access to the necessary work areas will be provided to the Engineer by the fabricator. Required test samples will be furnished free of charge. Material not inspected at the place of manufacture shall be subject to all chemical, physical, and workmanship requirements established for the material supplied. Materials or workmanship not in conformity with the specified product may be rejected. The Engineer may inspect and test all material by any visual, destructive, or nondestructive method to evaluate the material for its specified properties. Mill orders and certificates, showing test values obtained, must be furnished in triplicate to the Engineer. All certified test reports must include physical and chemical test results and steel making process used. All steel not identified by mill heat numbers shall be rejected. Acceptance of any material at the fabrication shop prior to incorporation into the work shall not prevent the rejection of the material or finished member if defects are discovered during the fabrication process.

Inspection in the fabrication shop is intended as a means of facilitating the work and avoiding errors so far as possible. It is expressly understood that

shop inspection does not relieve the Contractor from responsibility for material or fabrication defects or errors and the necessity for replacement or correction of rejected materials and workmanship.

Shop inspection of rail pipe and tubes will in most cases be waived and the Contractor permitted to ship subject to inspection at the project site. The field inspection will cover the general appearance, size, thickness, etc., of the pipe and tubing. Conformance of chemical and mechanical properties to requirements of the specifications will also be considered before the material is approved. Shop inspection of rail posts will be made on the first few rail post castings furnished for each project in order to establish a satisfactory class of finish and workmanship. When shop inspection is waived on a portion of the handrail posts for a project, a careful inspection will be made in the field to determine the acceptability of these posts on the basis of the finish and workmanship as compared to that of the other posts previously inspected and approved.

Fabrication of aluminum alloy material shall, in general, conform to or be equivalent to fabrication methods and practices recommended in the handbooks of the major producers of aluminum materials and specifically the following requirements:

(a) Material shall be sawed, routed, or milled.

(b) Flame cutting is not permissible.

(c) Tubing may be heated to a temperature not exceeding four hundred (400) degrees Fahrenheit for a period not exceeding fifteen (15) minutes to facilitate bending.

(d) Holes in pipe and tubing shall be drilled. Holes in castings shall be cored and reamed, or drilled from the solid. Seats for pipe shall be finished smooth.

The fabrication and handling of aluminum materials in the shop and field shall be performed in a manner to prevent scoring or marring of the surfaces. An objectionable appearance resulting from such scoring or marring shall be cause for rejection of the material. Sleeves and rails shall be fabricated in lengths indicated on the plans.

The finishing of rail posts shall be performed after fabrication is completed. All fins, pipes, and other casting irregularities and all drilling, reaming, and other fabrication marks shall be removed.

506.03.04 Storage. The loading, transporting, unloading, storing, and handling of the structural steel shall be conducted so that the metal will be kept clean and free of grease and other foreign material. Material to be stored shall be placed above the ground on skids, platforms, or other supports. In addition the material shall be properly drained and protected from corrosion. All material for the project shall be stored separate from "in stock" materials. Different grades or classifications of material shall be color coded as provided for in ASTM Designation A6. This color code must be transferred throughout fabrication.

Girders and beams shall be placed upright above ground and shored. Other members such as columns, chords, cross-frames, wind bracing, etc., shall be supported above the ground on skids placed near enough together to prevent injury from deflections.

506.03.05 Straightening. Rolled material before being laid out or worked shall be straight. Methods of straightening shall be in accordance with ASTM Designation A6.

Subassemblies and completed members shall be straight before being incorporated into the work. If straightening is necessary it shall be done by methods acceptable to the Engineer and in accordance with AWS D1.1–80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition.

Details of methods proposed for straightening of rolled material, subassemblies, or completed members shall be submitted in writing to the Engineer prior to their use. In addition a detailed procedure for correcting camber shall be submitted to the Engineer for approval. After straightening or correcting camber, evidence of fracture or other damage will be cause for rejection of the material.

If required, beams and girders shall be curved by either: (1) precutting curved flanges or (2) heat curving the members after fabrication. The heat curving shall be in accordance with Division II, Article 10.5 of AASHTO Standard Specifications for Highway Bridges, Thirteenth Edition. The procedure used shall be submitted to the Engineer for review and approval.

506.03.06 Blank.

506.03.07 Blank.

506.03.08 Blank.

506.03.09 Punching, Subpunching, Drilling, and Reaming. Unless otherwise specified, connections and splices (shop and field) of main truss or arch members, continuous beams, plate girders, rigid frames, and web splices shall either be subpunched (or subdrilled) and reamed while shop assembled or drilled to full size from the solid while assembled at the shop. Full size punching of holes will be allowed on intermediate stiffeners, bearing stiffeners, cross bracing, wind bracing, and diaphragms.

Punching and subpunching of structural steel conforming to ASTM A36 shall not be permitted on material thicker than seven-eighths (7/8) inch or thicker than three-fourths (3/4) inch for high strength structural steel. Holes subpunched for reaming shall be subpunched one-fourth (1/4) inch less in diameter than the finished hole.

Reamed or drilled holes shall be cylindrical and perpendicular to the member. Oversize or slotted holes shall not be permitted unless specified on the plans, except as noted in subsection 506.03.10, "Bolts and Bolted Connections." Reamers shall be directed by mechanical means where practicable. Burrs on the outside surfaces shall be removed. Poor matching of holes shall be cause for rejection. Reaming and drilling shall be done by twist drills.

Unless otherwise specified each individual (full length) truss, arch, continuous beam, or plate girder shall be assembled at the shop before reaming or drilling is commenced. During shop assembly all members shall be supported at such intervals and in such manner as is necessary to avoid undesirable deflections.

Drilling through templates shall be permitted only after the templates have been securely placed and firmly clamped or bolted. All parts shall be securely held together during drilling operations.

All holes for floor beams and stringer field end connections shall be subpunched and reamed to a steel template.

Mispunched or misdrilled holes shall not be corrected by welding, unless approved by the Engineer.

506.03.10 Bolts and Bolted Connections. (a) General. Bolts shall be of such length that they will extend entirely through the nut but not more than three-eighths (3/8) inch beyond. The Contractor shall furnish sufficient bolts of each type for each size and length to bolt such connections as called for with an ample surplus to replace those lost or rejected.

The holes, except holes in end diaphragms, shall be truly cylindrical. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. Bolts shall be driven accurately into the holes without damaging the thread.

Bolt holes in end diaphragms shall be slotted one-half (1/2) inch in addition to the dimensions shown on the plans, in the direction to facilitate erection. At all locations where such slotted bolt holes are required, circular washers shall be placed on each side of the bolted connection and the necessary bolt length adjusted accordingly.

Bolts in end diaphragm to girder connections shall not be tightened until the deck pour has been completed.

All bolted connections shall be fastened with high-tensile-strength bolts.

(b) High-Tensile-Strength Bolts. 1. General. This article covers the assembly of structural joints using AASHTO M164 (ASTM A325) or AASHTO M253 (ASTM A490) high strength bolts, or equivalent fasteners, tightened to a high tension.

2. Bolts, Nuts, and Washers. Bolts, nuts, and washers shall conform to the requirements of subsection 710.03.03, "High Strength Bolts," except the use of lock-pin and collar fasteners shall not be permitted.

3. Bolted Parts. The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed one (1) to twenty (20) with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material.

When assembled, all joint surfaces, including those adjacent to the bolt head, nuts, or washers, shall be free of scale, except tight mill scale, and shall also be free of burrs, dirt, and other foreign material that would prevent solid seating of the parts. Paint is permitted unconditionally in bearing-type connections.

In friction-type conditions the class, as defined below, indicating the condition of the contact surfaces shall be specified on the plans. Where no class is specified all joint surfaces shall be free of scale, except tight mill scale, and shall not have vinyl wash.

Class A, B, and C (uncoated). Contact surfaces shall be free of oil, paint, lacquer, or other coatings.

Class D (hot dip galvanized and roughened). Contact surfaces shall be lightly scored by wire brushing or blasting after galvanizing and prior to assembly. The wire brushing treatment shall be a light application of manual or power brushing that marks or scores the surface but removes relatively little of the zinc coating. The blasting treatment shall be a light "brush-off" treatment which will produce a dull gray appearance. However, neither treatment should be severe enough to produce any break or discontinuity in the zinc surface.

Class E and F (blast-cleaned, zinc rich paint). Contact surfaces shall be coated with organic or inorganic zinc rich paint as defined in the Steel Structures Painting Council System SSPC 12.00.

Class G and H (blast-cleaned, metallized zinc or aluminum). Contact surfaces shall be coated in accordance with AWS C2.2. Recommended Practice for Metallizing with Aluminum and Zinc for Protection of Iron and Steel, except that subsequent sealing treatments, described in Section IV therein, shall not be used.

Class I (vinyl-wash). Contact surfaces shall be coated in accordance with the provisions of the Steel Structures Painting Council Pretreatment Specifications SSPC PT3.

High-tensile-strength bolts shall not be galvanized unless shown on the plans. AASHTO M164 (ASTM A325) Type 2 and AASHTO M253 (ASTM A490) bolts shall not be galvanized nor shall they be used to connect galvanized material.

4. Installation. a. Bolt Tension. Each fastener shall be tightened to provide, when all fasteners in the joint are tight, at least the minimum bolt tension shown in Table I for the size of fastener used.

If required because of bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten (10) seconds.

AASHTO M253 (ASTM A490) and galvanized AASHTO M164 (ASTM A325) bolts shall not be reused. Other AASHTO M164 (ASTM A325) bolts may be reused, but not more than once, if approved by the Engineer. Retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered as a reuse.

b. Washers. All fasteners shall have a hardened washer under the element (nut or bolt head) turned in tightening. Hardened washers shall be used under both the head and nut regardless of the element turned in the case of AASHTO M253 (ASTM A490) bolts if the material against which it bears has a specified yield strength less than forty (40) p.s.i.

Where an outer face of the bolted parts has a slope of more than one (1) to twenty (20) with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of perpendicularity.

c. Tightening by Use of a Load Indicating Fastener System. Tightening will be by a load indicating fastener system. Unless otherwise indicated, the authorized load indicating fastener shall be a specially hardened washer with protrusions on one (1) face. Tightening shall be by the manufacturer's

TABLE I

BOLT TENSION
Minimum Bolt Tension in Pounds[1]

Bolt Size, in Inches	AASHTO M164 (ASTM A325) Bolts, p.s.i.	AASHTO M253 (ASTM A490) Bolts, p.s.i.
1/2	12,050	14,900
5/8	19,200	23,700
3/4	28,400	35,100
7/8	39,250	48,500
1	51,500	63,600
1 1/8	56,450	80,100
1 1/4	71,700	101,800
1 3/8	85,450	121,300
1 1/2	104,000	147,500

[1]Equal to seventy (70) percent of specified minimum tensile strength of bolts.

methods and procedures and shall have the approval of the Engineer. Certification shall be supplied by the manufacturer that the fastener used is able to indicate that the bolt has been tightened to obtain the bolt tension in accordance with Table I.

5. Inspection. The Engineer shall determine that the requirements of subsection 506.03.10(b)1 through 4 of this subsection are met in the work.

The Engineer shall observe the installation and tightening of bolts to determine that the approved procedure is properly used and shall determine that the correct indication of tension has been achieved.

506.03.11 Shop Assembly. Shop assembly of trusses, arches, continuous beams, plate girders, and rigid frames shall be according to subsection 506.03.09 "Punching, Subpunching, Drilling, and Reaming." All members shall be match marked before being disassembled.

The several component parts of a built-up member shall be straight and close fitting.

Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before drilling and reaming. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the operation. The member shall be free from twists, bends, and other deformations.

The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal.

Connecting parts in the shop for the purpose of reaming holes in field connections shall be match marked, and a diagram showing such marks shall be furnished to the Engineer.

A camber diagram shall be furnished to the Engineer showing the camber at each panel point in the cases of trusses, and at field splices and one-tenth (1/10) points of span for beams, girders, and rigid frames. The final camber shall be checked on the fully assembled girders in the "no load" position for rolled beams and I-plate girders, and in the "dead load" position for box plate girders. The bolts in the field splice need not have the final tension applied. Only enough tension need be applied to adequately keep the assembled section together for the camber measurements.

Prior to fabrication a handling procedure for box plate girders shall be

submitted to the Engineer for approval. The procedure shall be such that no undue stresses are applied to the flange to web welds.

506.03.12 Edge Planing. Sheared edges of plates more than five-eighths (5/8) inch in thickness and carrying calculated stress shall be planed to a depth of one-fourth (1/4) inch. Re-entrant cuts shall be filleted to a radius of three-fourths (3/4) inch.

506.03.13 Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the American National Standards Institute surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part 1:

Steel slabs	ANSI 2,000
Heavy plates in contact in shoes to be welded	ANSI 1,000
Milled ends of compression members, stiffeners, and fillers	ANSI 500
Bridge rollers and rockers	ANSI 250
Pins and pin holes	ANSI 125
Sliding bearings	ANSI 125

506.03.14 Abutting Joints. Abutting joints in compression members of trusses and in columns shall be milled.

Openings and abutting joints in tension members shall not exceed one-fourth (1/4) inch.

Abutting joints of rolled beams, plate girders, and box plate girders shall not exceed one-fourth (1/4) inch.

506.03.15 Flame Cutting. This work shall be in accord with provisions of AWS D1.1–80 and revisions as modified by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition.

506.03.16 End Connection Angles. Floorbeams, stringers, and girders having end connection angles shall be built to exact length shown on the plans measured between the heels of the connection angles with a permissible tolerance of plus zero (0) inch to minus one-sixteenth (1/16) inch. Where continuity is to be required, end connections shall be faced. The thickness of the connection angles shall not be less than three-eighths (3/8) inch, nor less than that shown on the detail drawings.

506.03.17 Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

506.03.18 Blank.

506.03.19 Shear Stud Connectors. Shear stud connectors shall be of a design suitable for end welding and shall be end welded to steel beams, girders, or plates with automatically timed stud welding equipment. The type, size, or diameter and length of stud shall be as specified in the contract documents. (See AWS D1.1–80 and revisions thereto as modified by

AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition, for allowable tolerances.) A maximum variation of one (1) inch from the location shown will be accepted provided the adjacent studs are not closer than two and one-half (2½) inches center to center. The clear distance between the edge of a girder flange and the edge of the shear connectors shall be not less than one (1) inch. Adequate provisions shall be made in the fabrication of structural members to compensate for loss of camber due to welding of the shear connectors.

Studs shall not be painted or galvanized. The studs shall be free from rust, scale, rust pits, and oil at the time of welding and immediately before the concrete is placed. The beam surface to which the studs are welded shall be free from excessive mill scale, rust, dirt, paint, grease, or any other material which might impair the quality of the weld. When necessary to obtain satisfactory welds, the areas on the beam, girder, or plate to which the studs are to be welded shall be wire-brushed, peened, prick-punched, or ground free of scale or rust.

The Contractor shall submit to the Engineer for approval, before installation, information on the studs to be furnished as follows:

(a) The name of the manufacturer.

(b) Detailed description of the stud and arc shield.

(c) A certification from the manufacturer that the stud is qualified as specified in AWS D1.1–80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition. The certifications must also indicate the heat from which the studs were manufactured.

Welding specifications and procedure requirements shall conform to AWS D1.1–80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition.

506.03.20 Welding. (a) General. All welding shall be performed in the fabrication shop, except as otherwise noted on the plans or permitted by the Engineer.

Automatic welding shall be used for all flange to web welds.

Shop splices of flanges or webs of main members shall be limited to locations where section changes occur, where shown on the plans, or as approved by the Engineer.

The weldments in butt splices of both webs and flanges shall be inspected and found satisfactory prior to performing web to flange connections.

Field splices shall be limited to the actual locations shown on the plans.

The use of additional field or shop splices, if required, shall be reviewed and approved in writing by the Engineer prior to fabrication.

Welding shall conform to the provisions of AWS D1.1–80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition, except the use of electroslag weldments will not be allowed.

All groove welds on primary members shall be finished smooth and flush with the base metal on all surfaces by grinding in the direction of applied stress, leaving surfaces free from depressions.

Extension bars or runoff tabs shall be used at the end of a joint in a manner that will ensure sound welds.

Fillet welds on stiffeners or gussett plates shall be terminated one-fourth (1/4) inch from the end of the plate or cope.

The minimum length of all welds shall be two (2) inches.

All welding on structural steel shall be only at locations shown on the shop drawings, including tack welds. The welding of lifting lugs or attachments will not be allowed.

The fabricator shall submit to the Engineer for his review all welding procedures for prequalified welds at no additional cost to the Department. In addition the Engineer reserves the right to test any prequalified weld, at no additional cost to the Department.

Shear stud connectors shall not be placed on shop splices, but may be moved up to three (3) inches either side of the splice if a conflict occurs.

Where weldments in both the web and flange fall at the same location, they shall be offset a minimum six (6) inches. When a stiffener falls at a location of a flange or web weldment, the stiffener shall be offset a minimum three (3) inches from the weldment.

Upon approval of the Engineer, shop splices may be located at points that are consistent with lengths of plate available from the mill and in areas of reduced tensile stress. To eliminate shop splices, the length of a thicker plate may extend to the end of a thinner plate or the end of a member. These changes, if approved by the Engineer, shall be shown on the shop drawings. Extra material and workmanship required by these changes shall be at no additional cost to the Department.

(b) Inspection-Testing. All shop and field welds shall be inspected to the provisions of AWS D1.1–80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition, Nevada Test Methods NHD 900, 901, 903, and these specifications.

Paragraph 6.1.3.1 of the AASHTO Welding Specifications is hereby deleted in its entirety and any reference to said paragraph in AWS or AASHTO is also deleted.

The Contractor shall visually inspect all welds and test welds in accordance with the requirements of this subsection of these specifications. The Engineer will make the final evaluation of the acceptability of all welds.

(c) Quality Control. Prior to any fabrication the Contractor shall submit, in writing, a quality control program to the Engineer. The program shall outline the quality control tasks to be performed by the Contractor to insure that the work conforms to the plans and these specifications. The quality control program shall also identify the Contractor's personnel who will be responsible for performing the quality control tasks.

(d) Supervision. Adequate supervision and inspection of all welds shall be provided by the Contractor to ensure satisfactory, consistent, and uniform workmanship. Repeated and chronic weld defects shall be considered as evidence that proper quality control and supervision procedures are not being provided.

(e) Time of Inspection. Visual inspection shall be continuous. Nondestructive testing of welds shall begin immediately after welding operations are

completed, except for ASTM A514 and A517 steels. Final nondestructive testing of welds for ASTM A514 and A517 steels shall not be performed until at least ninety-six (96) hours have elapsed after completing welding operations.

(f) Heat Numbers. Prior to nondestructive testing, the Contractor shall furnish to the Engineer heat numbers of all structural steel parts welded together to form a main member. Heat numbers of all plates separated into flange and web sections shall be transferred through steel stamping by the Contractor at his expense.

(g) Visual Inspection of Welds. Visual inspection will be performed by the Engineer at no expense to the Contractor, except as provided in the Contractor's quality control program. Inspection requirements and standards for visual acceptance shall be as stated in AWS D1.1–80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition, and Nevada Test Methods NHD 900, 901, and 903. All welds shall be inspected and accepted visually, and any required repairs made, prior to performing any nondestructive testing for acceptance.

(h) Testing Precedence. When both radiographic inspection and ultrasonic inspection are to be performed on a weld, radiographic inspection shall be performed prior to ultrasonic inspection except in flanges where acceptance is based on ultrasonic method.

(i) Radiographic Inspection. All radiographic testing and inspection will be performed by the Contractor at his expense.

1. Licensing Requirements. The agency performing the radiographic testing shall be currently licensed for the operation involving radioactive materials under the proper jurisdiction where such inspection is performed.

2. Testing Procedures Submittal. Before beginning fabrication of structural steel components, the Contractor shall submit in writing to the Engineer for approval, a copy of his proposed radiographic test procedures.

3. Resume. The Contractor shall furnish to the Engineer a resume listing the specific radiographic equipment and outlining the particular radiographic procedures proposed for use on the work. The Contractor shall furnish a statement to the Engineer detailing the radiographic training and experience for each person to be employed in radiographic testing and certifying that each of these persons is a competent radiographer or radiographer's assistant.

4. Scheduling. The Contractor shall schedule radiographic testing and notify the Engineer not less than twelve (12) hours in advance of the scheduled time and place for this testing, the items to be radiographed, and the radiographic agency to be utilized unless otherwise authorized by the Engineer. Radiographic testing shall be scheduled during daylight hours only unless requested in writing by the Contractor and approved by the Engineer. Blanket approval for an extended period may be given at the discretion of the Engineer.

Butt welds in girder flanges and webs shall not be radiographically inspected until the girder flange or web section is cut to its finished width.

5. Extent of Inspection. a. Groove Welds. The Contractor shall furnish to the Engineer, for his use in evaluating the acceptability of groove welds, radiographs, and radiographic reports for the following welds:

TABLE II

Radiographic Weld Inspection Schedule

Girder Material	Member	Tension/ Compression	Weld Orientation	Percent Inspection
All	Flange	Tension	Transverse	10
All	Flange	Compression	Transverse	5

Percent inspection on flange welds indicates the percentage of the total number of welds in the structure. Each weld designated for radiographic testing shall be tested for the entire length of the weld. The inspector will designate which welds to be tested.

Girder Material	Member	Tension/ Compression	Weld Orientation	Percent Inspection
All	Web	Tension	Transverse	100
All	Web	Compression	Transverse	100
All	Web	Tension	Longitudinal	10
All	Web	Compression	Longitudinal	10

Percent inspection on web welds indicates the percentage of the length to be tested on each individual web weld; however, a minimum of one (1) radiograph seventeen (17) inches in length at each end of all web welds is required. In addition, if the original radiographs show rejectable discontinuities, the area on each side of the defect, for a minimum length of seventeen (17) inches, shall be tested.

b. Additional Radiographic Inspection. The Engineer may perform radiographic inspection in addition to such inspection performed by the Contractor. The Contractor shall make available, at no cost to the State, the facilities used in his operations for use by the Engineer in performing such additional inspection. In the event such additional radiographic inspection discloses defective welds, repairing of the defective welds and reradiographic inspection shall be performed by the Contractor at his expense.

6. Radiographic Procedure. a. Requirement. The radiographic procedure used shall conform to the requirements in ASTM Designation E94, and the requirements of these specifications.

b. Film. Radiographs made on material whose thickness is nine-tenths (0.9) inch or less shall be done on Type I industrial radiographic film.

Radiographs made on material whose thickness is nine hundred one one-thousandths (0.901) inch to three and five-tenths (3.5) inches shall be done on Type II industrial radiographic film. All radiographic film shall conform to the requirements of ASTM Designation E94. The film shall be wide enough to fully span the width of the weld with sufficient excess to allow the specified location markers and other identification to show on the film outside of the weld area, but in no case shall the film be less than four and one-half (4 1/2) inches in width. The testing agency conducting the radiograph shall submit for approval all data concerning the film, including brand name and type, prior to any radiograph being performed on the project.

c. Process and Detail. Radiographs shall be made by either X-ray or gamma ray. All radiographs shall determine quantitatively the size of defects having thickness equal to or greater than two (2) percent of the thickness of

the thinner of the parts joined by the weld under examination. They shall be clean, free of film processing defects, shall have densities of not less than one and five-tenths (1.5) nor more than three (3) in the area of interest. Any gamma ray source used to radiograph welded material up to three (3) inches in thickness shall not exceed sixteen one-hundredths (0.16) inch across its greatest diagonal dimension.

Radiographs shall show the following:

(1) The 2T hole in each penetrameter.

(2) The penetrameter identification number.

(3) The radiograph identification and location marks indicated below under "Identification and Location Marks."

d. Film Development. Radiographic film shall be developed within the time and temperature range recommended by the film manufacturer. Sight development will not be permitted. The film shall be manually hot air dried to the satisfaction of the Engineer. The use of automatic driers will not be permitted.

e. Dual Film Technique. In the event that the greatest and least thickness of a weld joining parts of different thicknesses cannot both be rendered with a single exposure on a single film having densities within the limits specified under "Process and Detail," a dual film or dual exposure technique shall be used. These techniques shall be calibrated to obtain the required density for both the greatest and the least thickness of the weld. When these techniques are employed two (2) extra penetrameters shall be used in addition to the two (2) specified under "Penetrameters." The four (4) penetrameters shall be positioned so that at least one (1) penetrameter image appears at each end of each film on the plate thickness for which that film has been exposed.

f. Penetrameters. Two (2) or more penetrameters shall be used for each radiograph on a film ten (10) inches or more in length. Only one (1) penetrameter need be used for radiographs on film less than ten (10) inches in length. Penetrameters shall be placed on the side of the work nearest the source of radiation located as shown in the current edition of AWS. Penetrameters shall conform to the requirements in Table III of this subsection of these specifications. The thickness of each penetrameter shall be equal to or less than two (2) percent of the thickness of the thinner of the parts joined by the weld under examination, but need not be less than five one-thousandths (0.005) inch thick.

In each penetrameter there shall be three (3) holes, one (1) of which shall be of diameter equal to twice the nominal penetrameter thickness (2T) but not less than one-sixteenth (1/16) inch for X-ray and three thirty-seconds (3/32) inch for gamma ray. The diameter of the two (2) remaining holes shall be selected by the manufacturer. They will ordinarily be equal to three (3) times (3T) and four (4) times (4T) the penetrameter thickness but not be smaller than one-sixteenth (1/16) inch. Smaller holes are permitted. These holes shall be true and normal to the surface and not chamfered. For weld thickness less than one-half (1/2) inch, the penetrameter shall also contain a slit one-quarter (1/4) inch long by one one-hundredth (0.01) inch wide.

TABLE III

Standard Penetrameter Sizes

Weld Thickness Range	Thickness of Penetrameter on Source Side (Inch)	Example of Penetrameter Identification
Up to 1/4 inclusive	0.005	5
Over 1/4 thru 3/8	0.0075	7
Over 3/8 thru 1/2	0.010	10
Over 1/2 thru 5/8	0.0125	12
Over 5/8 thru 3/4	0.015	15
Over 3/4 thru 7/8	0.0175	17
Over 7/8 thru 1	0.020	20
Over 1 thru 1 1/4	0.025	25
Over 1 1/4 thru 1 1/2	0.030	30
Over 1 1/2 thru 2	0.035	35
Over 2 thru 2 1/2	0.040	40
Over 2 1/2 thru 3	0.045	45
Over 3 thru 4	0.050	50
Over 4 thru 6	0.060	60
Over 6 thru 8	0.080	80

g. Radiographic Exposure. Radiographs shall be made with a single source of radiation approximately centered with respect to the length of the weld being examined. The perpendicular distance from the radioactive source to the film shall be not less than seven (7) times the maximum thickness of the weld under examination and the rays shall not penetrate the weld at an angle greater than twenty-six and one-half (26 1/2) degrees from a line perpendicular to the weld surface. During exposure the film shall be placed at the opposite side to the source of radiation and as close to the surface of the weld as possible.

7. Identification and Location Marks. a. Fabrication. Radiographic identification for inspection of welds shall consist of the following:

(1) Contract number (State contract number).

(2) Weld Identification Number. The weld identification number shall consist of a sequence of digits conforming to the following:

(a) The fabrication number of the girder in which the radiographed weld occurs, followed by a dash (—).

(b) Letter combination designating the section in which the radiographed section occurred. The section shall be designated by the letters TF (Top Flange), BF (Bottom Flange), or the word Web.

(c) The joint designation consisting of the letter W preceded by a space and followed by a number. The number shall designate the joint in which the radiographed weld occurs and shall correspond to the number of welded joints between the reference or work end of the section and the radiographed weld.

(d) All weld identification numbers will be steel stamped.

(3) Identification of the company performing the radiograph.

(4) Radiographer's initials.

(5) Six numeric digits indicating "Month"—"Day"—"Year."

b. Erection. Radiograph identification for radiographs of welds performed after erection shall be designated by the Engineer.

c. Repairs. The weld identification number on radiographs of repaired welds shall be suffixed with the letter R and a number showing how many times the weld has been repaired.

d. Radiograph Location Marks. When complete radiographic coverage of a weld is specified, location or other supplementary match marks shall be placed to appear on the film in accordance with the provisions in Section 14 of ASTM Designation E94. Radiograph location marks will not be required for radiographs made at field construction sites. The location of radiographs made at field construction sites shall be indicated by a number added to the end of the weld identification number. Such a number, separated from the joint or splice number by a space, shall signify the location of radiographs on plate girder joints or splices when viewed ahead on line, as follows:

1....right side bottom flange
2....left side bottom flange
3....left side top flange
4....right side top flange
5....web adjacent to top flange

In the event additional radiographs of a given web weld are required, these will be identified as consecutive location numbers starting with seven (7). The exact location of such radiographs shall be approved by the Engineer and noted in the radiographic reports.

e. Radiographic Identification (Miscellaneous). The radiograph identification and marking system for welds on other than plate girder structures shall be established by agreement between the Contractor and the Engineer before radiographic inspection begins.

8. Examination, Reports, and Disposition of Radiographs.

a. Viewer. The Contractor shall provide a suitable high-intensity radiograph viewer at the place where radiographic inspection is performed.

b. Acceptance. Prior to acceptance by the Engineer of a weld subject to radiographic inspection by the Contractor, all radiographs including any that show unacceptable quality prior to repair, and a report interpreting them, shall be submitted to the Engineer.

c. Reports. The Contractor shall submit to the Engineer three (3) or more copies of the radiographic report showing the results of radiographic tests performed during each shift. This radiographic report shall include the following information:

(1) Date.
(2) Name and address of the radiographic inspection agency.
(3) Description of structure being inspected.
(4) Location of structure or fabrication site.
(5) Contract number.
(6) The specification being used to accept or reject welds radiographically inspected.
(7) Name and address of the fabricator.
(8) The radioactive source, type, and size (either current or dated strength), or X-ray unit type and size.
(9) Type of film used.
(10) The names of technicians performing the radiograph.
(11) The NDT numbers for the reported radiographs.
(12) The weld identification number for each radiograph.

(13) The item radiographed (flange, web, etc.) for each radiograph.

(14) The thickness of the item radiographed for each radiograph.

(15) The distance from the radioactive source or focal spot to the film for each radiograph.

(16) An interpretation of each radiograph providing an analysis of:

(a) Cracks.

(b) Porosity or gas holes.

(c) Slag or inclusion.

(d) Lack of fusion.

(e) Incomplete penetration.

(17) Acceptability of both weld and radiograph for each radiograph.

(18) Remarks (if any) concerning any unusual observation or condition in the weld or radiograph.

(19) Radiographer's signature.

d. Packaging. Radiographs and reports shall be packaged in suitable envelopes and shall be clearly marked on the outside with the following identification:

(1) The contract number.

(2) The fabricator.

(3) The NDT report numbers for the radiographs in the package.

e. Disposition of Reports. After review and approval of radiographic reports the Engineer will retain the original and two (2) copies of the reports together with the radiographs. All additional copies of the reports will be returned to the Contractor.

(j) Ultrasonic Inspection of Welds. 1. General. Ultrasonic inspection will be performed by the Engineer at no expense to the Contractor except for joint preparation. Inspection method shall be as provided for in AWS D1.1–80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition.

2. Extent of Ultrasonic Inspection. Ultrasonic inspection will be performed on one hundred (100) percent of the total weld length of groove welds in all flange welds.

3. Location. The locations for ultrasonic inspection will overlap locations selected for radiographic inspection. Flange welds shall be accepted by ultrasonic method. Radiographs taken in areas of previously accepted welds shall be for documentation only.

4. Scheduling of Inspection. The Engineer will schedule ultrasonic inspection and evaluation at the request of the Contractor subject to the following conditions:

a. If the Contractor only provides time and space for ultrasonic inspection intermittently, each time he requires such inspection he shall submit his request to the Engineer not less than twenty-four (24) hours in advance. This request shall identify the welds that are ready to be inspected so that the Engineer can verify the accessibility and preparation of these welds before he schedules the requested ultrasonic inspection.

b. If the Contractor schedules fabrication and erection at such a rate that he can support continuous ultrasonic inspection and evaluation, and if he provides time and space for this inspection to proceed in an uninterrupted

manner, he shall maintain and provide the Engineer or the Engineer's agent with a six (6) hour notice of the identity and location for each of the welds that are ready for inspection. This will allow time for the Engineer or his agent to optimize his ultrasonic inspection schedule.

5. Weld Preparation. Ultrasonic inspection and evaluation will not be scheduled until welds have been prepared by the Contractor as follows:

a. Web-to-flange fillet welds within six (6) inches of either side of the butt weld to be inspected shall be withheld until after ultrasonic inspection has been completed and the butt weld has been accepted.

b. All shear studs, stiffeners, brackets, bolt holes, and other projections or obstructions within the ultrasonic scanning zone shall be removed or left off until after ultrasonic inspection has been completed and the butt weld has been accepted.

c. Backup plates and run-off tabs, if any, shall be removed.

d. Welds shall be ground flush and smooth with a maximum roughness not to exceed two hundred fifty (250) micro inches rms.

e. All loose mill scale, rust, dirt, grease, oil, grime, weld spatter, etc., shall be removed from the scanning zone and the flange or plate surfaces within the zone shall be finished flush.

f. Paint shall be removed.

6. Inspection Procedure. Ultrasonic inspection and evaluation by the Engineer will be performed in conformance with the following:

a. Ultrasonic inspection and evaluation will be performed only during daylight hours unless otherwise allowed by the Engineer.

b. Ultrasonic inspection and evaluation will not be performed at unsafe locations or locations not readily accessible.

c. Ultrasonic inspection will not be performed in the presence of rain, snow, or blowing sand, or when the wind velocity exceeds ten (10) mph, except under shelter approved by the Engineer.

d. Ultrasonic inspection and evaluation will be performed only when the temperature of the steel is above forty (40) degrees F. but not above one hundred twenty (120) degrees F.

e. Prior to the initiation of ultrasonic inspection joints shall be visually inspected for surface defects and conformance to joint preparation requirements.

(k) Dye Penetrant Inspection of Welds. The use of dye penetrant inspection shall be at the discretion of the Engineer.

When dye penetrant inspection is required by the Engineer, the procedure ASTM E165, and the standards set forth in AWS D1.1–80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Bridges, Third Edition, and Nevada Test Methods NHD 900, 901, and 903 shall control the work.

(l) Magnetic Particle Inspection of Welds. The use of magnetic particle inspection shall be at the discretion of the Engineer.

When magnetic particle inspection is required by the Engineer the procedure ASTM E709 and standards set forth in AWS D1.1–80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Bridges, Third Edition, and Nevada Test Methods NHD 900, 901, and 903 shall control the work.

(m) Marking of Welds for Repair. Defective welds will be clearly marked by the Engineer in the presence of the Contractor on the surface and side repairs will be made from. Markings will clearly indicate the length and depth of the defect. Defect length will be noted by a line on the surface directly over the defect, running the entire length of the defect. Depth from the noted surface will be marked (out of the weld area) with a suitable line or arrow referencing the applicable defect.

(n) Allowable Number of Repairs. When any weld has been repaired three (3) times and rejected four (4) times, hardness tests shall be performed by the Engineer or his authorized representative. Acceptable values shall be determined by the Department's Materials and Testing Division for weld metal and the heat affected zone depending on the type of base metal. If the hardness values exceed the permissible range then the weld and heat affected material shall be completely removed.

506.03.21 Fit of Stiffeners. The fit of stiffeners shall be as specified in AWS D1.1–80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Bridges, Third Edition.

506.03.22 Annealing and Stress Relieving. Annealing and stress relieving shall be as specified in Division II, Article 10.26 of the AASHTO Standard Specifications for Highway Bridges.

506.03.23 Pins, Rollers, and Pin Holes. Rollers shall be of structural carbon steel and pins shall be of carbon steel forgings meeting the requirements of subsection 710.03.08, "Pins and Rollers." Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. Final surface shall be produced by a finishing cut.

In pins larger than nine (9) inches in diameter a hole not less than two (2) inches in diameter shall be bored full length along the axis after the foregoing has been cooled to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

Pin holes shall be bored true to the specified diameter, smooth and straight at right angels with the axis of the member and parallel with each other unless otherwise specified.

The distance outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from that specified by more than one thirty-second (1/32) inch. Boring of holes in built up members shall be done after the bolting is complete.

The diameter of the pin hole shall not exceed that of the pin by more than one-fiftieth (1/50) inch for pins five (5) inches or less in diameter, or more than one thirty-second (1/32) inch for larger pins.

Screw threads for all bolts and pins for structural steel construction shall conform to the American National Coarse Thread Series, Class 2, free fit, except that pin ends having a diameter of one and three-eighths (1 3/8) inches or more shall be threaded six (6) threads to the inch.

Pilot and driving nuts shall be used in driving pins. They shall be furnished by the Contractor without charge. Two (2) pilot nuts and two (2) drifting nuts

for each size of pin shall be furnished, unless otherwise specified. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

506.03.24 Shop Painting. Unless otherwise provided the application of shop paints shall conform to the requirements of Section 614, "Painting."

Surfaces to be in contact after shop bolting is completed shall be cleaned but shall not be painted.

506.03.25 Marking and Shipping. Each member shall have an erection mark permanently stamped into the metal for identification and an erection diagram shall be furnished with erection marks shown thereon. Painted erection marks shall not be permitted. Members weighing more than three (3) tons shall have the weight marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged. All girders must be shipped in a vertical position which shall be maintained in subsequent operations, or as approved by the Engineer.

506.03.26 Erection Methods and Equipment. Fifteen (15) days prior to the start of erection the Contractor shall inform the Engineer in writing as to the method of erection he proposes to follow, and as to the amount and character of the equipment he proposes to use, the adequacy of which shall be subject to the approval of the Engineer. Storage and handling of the beams or girders on the erection site shall conform to subsections 506.03.04, "Storage," and 506.03.11, "Shop Assembly." The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety and adequacy of his methods or equipment or from carrying out the work in full accordance with the plans and specifications.

Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while bolting will not be permitted.

All work of erection shall be subject to inspection and the Contractor shall furnish facilities for such inspection of material and workmanship. Material and workmanship not previously inspected shall be inspected after its delivery to the site of the work.

The Contractor shall provide the falsework and all tools, machinery, and appliances, including drift pins and fitting up bolts, necessary for the expeditious handling of the work.

Anchor bolts for rail posts shall be galvanized high-strength bolts set with suitable templates in exact position and securely fixed to prevent displacement during the concreting operations. The areas of concrete upon which posts are to be set shall be dressed by grinding and rubbing to a true plane for the proper seating of the posts. All surfaces of aluminum alloy posts and adjustment shims to be in contact with concrete or with the steel anchor bolts, nuts, and washers shall be coated with aluminum insulating compound.

Rail posts shall be erected in sections. Erection of sections of rails and posts shall continue successfully until all or an approved portion of the required rail is erected. The rail shall then be aligned and the nuts on the anchor bolts

tightened. In final adjustment no posts shall deviate more than one-eighth (1/8) inch from true alignment and there shall be no abrupt break in alignment at any location. Aluminum shims may be slotted for ease in placing if approved by the Engineer.

506.03.27 Falsework. The falsework shall be properly designed and substantially constructed and maintained for the loads which come upon it. The Contractor shall prepare and submit to the Engineer for approval plans for falsework or for changes in an existing structure necessary for maintaining traffic. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

Holes for falsework and forms shall be shown on the shop drawings. Holes shall be located such that distortion of the web shall not occur. Temporary ties and struts shall be required when necessary to resist lateral loads and control relative deflections.

Welding of falsework supports shall be limited to compression flanges only, as approved by the Engineer.

Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless materials, rubbish, and temporary buildings, replace or renew any fences damaged, restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of the work, and leave the structure site and adjacent highway in a neat and presentable condition satisfactory to the Engineer.

All excavated material or falsework placed in the stream channel before construction shall be removed by the Contractor before final acceptance.

At a time to be determined by the Engineer and when applicable, the Contractor shall remove and dispose of temporary crossframes between the box plate girders.

506.03.28 Bearing and Anchorage. Bridge bearings shall set in exact position as shown on the plans and shall have full and even bearing on the masonry. Bridge bearings shall not be placed on masonry bearing areas which are irregular or improperly formed.

Cast iron, steel, or rolled steel bearings shall be bedded on the masonry with alternate layers of red lead and canvas, a single thickness of sheet lead, or preformed elastomeric bearing pads as shown on the plans.

Surfaces designed for sliding movement, one upon the other, shall be given a field coat of graphite grease when placed in the structure.

The Contractor shall drill the holes and set and anchor bolts, except where the holes are formed or the bolts are built into the masonry. The bolts shall be set accurately and fixed with Portland cement grout, completely filling the holes. The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit free movement of the span.

Elastomeric bearing pads shall conform to the requirements specified in subsection 502.03.13, "Expansion and Fixed Joints and Bearings," and Section 725, "Elastomeric Bearing Pads."

506.03.29 Field Assembly. If the contract covering the erection of the steel does not include the fabrication, the Contractor shall check the material received by him and report promptly, in writing to the Engineer, any shortage or injury discovered. The parts shall be accurately assembled as shown on the plans and match-marks shall be followed. The material shall be carefully handled so that no part will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled.

Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber.

506.03.30 Misfits. The correction of minor misfits involving nonharmful amounts of reaming, cutting, and chipping shall be considered a legitimate part of the erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents the proper assembling and fitting up of the parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the Engineer and his approval of the method of correction obtained. The correction shall be made in his presence. The Contractor shall be responsible for all misfits, errors, and injuries and shall make the necessary corrections and replacements.

506.03.31 Field Painting. Structural steel, unless otherwise specified, shall be painted as specified in Section 614, "Painting."

METHOD OF MEASUREMENT

506.04.01 Measurement. Measurement of structural steel will be either by the pound or lump sum as follows except that bridge and pedestrian rail may be measured by the linear foot.

(a) Pound Basis. When structural steel is measured for payment by the pound, the calculated poundage shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment. The Engineer or the Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes, and quantities derived therefrom will be the quantities used for payment.

The calculated weight shall be based on the following assumptions:

1. Unit weights, pounds per cubic foot:

Iron, malleable	470.00
Iron, wrought	487.00
Steel, rolled, cast, copper bearing, silicon, nickel, and stainless	490.00

The quantity of structural steel measured for payment will be the number of pounds complete and in place except that additional weight of substitution made at the Contractor's request will not be included.

2. The weight of bolts, cap screws, anchor bolts, nuts, washers, and anchor pipe sleeves remaining in the finished structure will be computed on the basis of their nominal weight and dimensions.

3. The weight of paint will not be included in the computed weight of metals.

4. The weight of weld metal will be computed on the basis of the theoretical volume of the dimensions of the welds with no allowance of overrun.

(b) Lump Sum Basis. When specified, structural steel acceptably completed in the structure as shown on the plans will be measured for payment by the lump sum. There will be no change in measurement due to substitutions made at the Contractor's request.

Bridge rail or pedestrian rail shall be measured by the linear foot of rail installed, complete in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

506.05.01 Payment. The accepted quantity of structural steel measured as provided in subsection 506.04.01, "Measurement," shall be paid for at the contract unit price bid per pound or lump sum for structural steel as set forth for the bid item in the proposal.

The additional steel in substitutions made at the Contractor's request will not be paid for.

The price per pound or lump sum shall constitute full compensation for doing all the work involved in furnishing, fabricating, delivering, erecting, and painting the steel work in accordance with the details shown on the plans and as herein specified, including furnishing of mill test reports and test specimens, except the specimens for full size tests.

Unless otherwise specified and provided for in the proposal, the lump sum price shall include all specified and approved metal in the finished structure including but not limited to bolts, nuts and washers, stud connectors, scuppers and deck drains, castings, pier nose angles, expansion joint angles and supports, elastomeric bearing pads, plates, anchorages, welding materials, galvanizing where specified and conforming to the qualification and testing requirements associated with member fabrication as shown on the plans and specified in the specifications.

When applicable, the cost of removing and disposing of the temporary crossframes between the box plate girders will not be measured or paid for directly but shall be considered included in other items of work.

The cost of stockpiling completed fabricated material on the fabrication site, until the time of erection, will be included in the unit price for this item as provided in the proposal.

Bridge rail or pedestrian rail shall be paid for at the contract unit price bid per linear foot for the type specified whether constructed of steel or aluminum which payment shall be full compensation for furnishing, fabricating, delivering, erecting, painting, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the item and for furnishing mill test reports and test specimens.

Full compensation for conforming to the welder qualification requirements of this section shall be considered as included in the contract price paid per pound or lump sum for structural steel and no separate payment will be made therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Structural Steel	Pound or Lump Sum
Bridge Rail (type)	Linear Foot
Pedestrian Rail (type)	Linear Foot

SECTION 507

TIMBER STRUCTURES

DESCRIPTION

507.01.01 General. This item shall consist of furnishing, framing, and installing timber of the kind, sizes, and dimensions and in accordance with the lines, grades, and sections shown on the plans.

MATERIALS

507.02.01 General. Materials shall meet the requirements of the following sections:

Structural and Eyebar Steel	Section 710
Paint	Section 714
Miscellaneous Metals	Section 712
Hardware	Section 723
Timber	Section 718
Timber Preservative	Section 719

If material lists or order lists are sent by the Contractor to the Engineer for checking or approval, such checking or approval by the Engineer shall in no way relieve the Contractor of responsibility for the correctness of such lists. Any expenses incident to the revision of materials furnished in accordance with such lists to make them comply with the design drawings shall be borne by the Contractor.

All framing lumber and structural timber, unless otherwise specified or shown on the plans, shall be Douglas Fir or West Coast Hemlock or Larch.

Structural glued laminated timber shall conform to the National Bureau of Standards. Voluntary Product Standard PS 56–73 for Structural Glued Laminated Timber.

Structural lumber and timber, solid sawn or glued laminated, shall not be used in exposed permanent structures without a pressure preservative treatment unless otherwise noted on the plans or in the special provisions.

Timber connectors for treated timber structures, except those of malleable iron, shall be galvanized.

Split ring connectors of two and one-half (2½) inch inside diameter and four (4) inch inside diameter shall be manufactured from hot rolled, low-carbon steel. Each ring shall form a closed true circle with the principal axis of the cross section of the ring metal parallel to the geometric axis of the ring. The metal section shall be beveled from the central portion toward the edges to a thickness less than the midsection. It shall be cut through in one (1) place in its circumference to form a tongue and slot.

Shear-plate connectors of the pressed steel type, two and five-eighths (2⅝) inches in diameter, shall be manufactured from mild steel. Each plate shall be a true circle with a flange around the edge, extending at right angles to the face of the plate and extending from one (1) face only, the plate portion having

a central bolt hole and two (2) small perforations on opposite sides of the hole and midway from the center and circumference.

Shear-plate connectors of the malleable iron type, four (4) inches in diameter, shall be manufactured according to ASTM A47, Grade 35018, for malleable iron castings. Each casting shall consist of a perforated round plate with a flange around the edge extending at right angles to the face of the plate and projecting from one (1) face only, the plate portion having a central bolt hole reamed to size with an integral hub concenteric to the bolt hole and extending from the same face as the flange.

Spike-grid timber connectors shall be manufactured according to ASTM A47, Grade 35018, for malleable iron castings. They shall consist of four (4) rows of opposing spikes forming a four and one-eighth (4 1/8) inch square grid with sixteen (16) teeth that are held in place by fillets. Fillets for that flat grid in cross section shall be diamond shaped. Fillets for the single curve grids shall be increased in depth to allow for curvature and shall maintain a thickness between the sloping faces of the fillets equal to the width of the fillet.

Circular grids of three and one-fourth (3 1/4) inch diameter shall consist of eight (8) opposing spikes equally spaced around the outer circumference and held in place by connecting fillets around the outer diameter and radial fillets projecting to a central circular fillet which forms a bolt hole opening of one and one-fourth (1 1/4) inch. Fillets in cross section shall be diamond shaped except that the inner circular fillet may be flattened on one (1) side to provide for manufacturer identification.

CONSTRUCTION

507.03.01 Storage of Materials. Lumber and timber on the site of the work shall be stored in piles.

Untreated material shall be open-stacked at least twelve (12) inches above the ground surface and piled to shed water and prevent warping. When required by the Engineer, it shall be protected from the weather by suitable covering.

Treated timber and piling shall be close-stacked and piled to prevent warping.

The ground underneath and in the vicinity of all material piles shall be cleared of all weeds and rubbish.

507.03.02 Workmanship. Workmanship shall be first class throughout. None but competent bridge carpenters shall be employed, and all framing shall be true and exact. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal of the workman causing them. The workmanship on all metal parts shall conform to the requirements specified in Section 506, "Steel Structures."

507.03.03 Treated Timber. Treated timber and piling shall be carefully

handled without sudden dropping, breaking of the outer fibers, bruising, or penetrating the surface with tools. Material shall be handled with slings. Cant hooks, peaveys, pikes, or hooks shall not be used.

All cutting, framing, and boring of treated timbers shall be done before treatment insofar as is practicable.

All cuts in treated piles of timbers, and all abrasions, after being carefully trimmed, shall be covered with two (2) applications of a mixture of sixty (60) percent creosote oil and forty (40) percent roofing pitch, or brush coated with at least two (2) applications of hot creosote oil and covered with hot roofing pitch.

All bolt holes, bored after treatment, shall be treated with creosote oil by means of an approved pressure bolt hole treater. Unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

Whenever, with the approval of the Engineer, forms or temporary braces are attached to treated timber with nails or spikes, the hole shall be filled by driving galvanized nails or spikes flush with the surface or plugging holes as required for bolt holes.

507.03.04 Untreated Timber. In structures of untreated timber the following surfaces shall be thoroughly coated with two (2) coats of hot creosote oil before assembling: Ends, tops, and all contact surfaces of sills, caps, floors, and stringers; and all ends, joints, and all contact surfaces of bracing and truss members. The back faces of bulkheads and all other timber which is to be in contact with earth, metal, or other timber shall be similarly treated.

Unless untreated timber is to be used in the construction within three (3) days after date of delivery, it shall be painted on each end with a prime coat at time of delivery.

507.03.05 Holes for Bolts, Dowels, Rods, and Lag Screws. Holes for round drift-holes and dowels shall be bored with a bit one-sixteenth (1/16) inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.

Holes for rods shall be bored with a bit one-sixteenth (1/16) inch greater in diameter than the rod.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

507.03.06 Bolts and Washers. A washer of the size and type specified shall be used under all bolt heads and nuts which would otherwise come in contact with wood.

The nuts of all bolts shall be effectively locked after they have been finally tightened.

Countersinking shall be done whenever smooth faces are required. Horizontal recesses formed for countersinking shall be painted with hot creosote oil, and after the bolts are screwed in place, shall be filled with hot pitch.

507.03.07 Framing. All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full depth and tenons shall fit snugly. No shimming will be permitted in making joints, nor will open joints be accepted.

Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place.

Concrete pedestals for the support of framed bents shall be carefully finished so that the sills or posts will take even bearing on them. Dowels of not less than three-fourths (3/4) inch diameter and projecting at least six (6) inches above the tops of the pedestals shall be set in them when they are cast, for anchoring the sills or posts.

Sills shall have true and even bearing on mud sills, piles, or pedestals. They shall be drift-bolted to mud sills or piles with bolts of not less than three-fourths (3/4) inch diameter and extending into the mud sills or piles at least six (6) inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

Posts shall be fastened to pedestals with dowels of not less than three-fourths (3/4) inch diameter, extending at least six (6) inches into the posts.

Posts shall be fastened to sills by one (1) of the following methods, as indicated on the plans:

(a) By dowels of not less than three-fourths (3/4) inch diameter, extending at least six (6) inches into posts and sills.

(b) By drift-bolts of not less than three-fourths (3/4) inch diameter driven diagonally through the base of the post and extending at least nine (9) inches into the sill.

507.03.08 Caps. Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift-bolts, as indicated on the plans, extending at least nine (9) inches into the posts or piles. Drift-bolts shall be approximately in the center of the post or pile.

507.03.09 Bracing. The ends of bracing shall be bolted through the pile, post, or cap with a bolt of not less than five-eighths (5/8) inch diameter. Intermediate intersections shall be bolted, and spiked with wire or boat spikes, as indicated on the plans. In all cases spikes shall be used in addition to the bolts.

507.03.10 Stringers. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the top portions of the stringers.

Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least one-half (1/2) inch for the circulation of air and shall be securely fastened by drift-bolts where specified. When stringers are two (2) panels in length the joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two (2) nails at each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified in the contract, cross-bridging shall be placed at the center of each span.

507.03.11 Plank Floors. Unless otherwise specified, flooring plank shall be surfaced one (1) side and one (1) edge. Single plank floors shall consist of a single thickness of plank supported by stringers or joists. The plank shall be laid heart side down with one-fourth (1/4) inch openings between them for locally seasoned material and with tight joints for unseasoned material. Each plank shall be securely spiked to each joist. The plank shall be carefully graded as to thickness and so laid that no two (2) adjacent planks will vary in thickness more than one-sixteenth (1/16) inch.

Two (2) ply timber plank floors shall consist of two (2) layers of flooring supported on stringers or joists. The lower course shall be pressure-treated with a creosote oil. The top course may be laid either diagonal or parallel to the centerline of the roadway, as specified, and each floor piece shall be securely fastened to the lower course. Joints shall be staggered at least three (3) feet. If the top flooring is placed parallel to the centerline of the roadway, special care shall be taken to securely fasten the ends of the flooring. At each end of the bridge these members shall be beveled.

507.03.12 Laminated Floors. Laminated floors shall be composed of three (3) by six (6) inch or two (2) by six (6) inch timbers, as indicated on the plans, laid on edge at right angles to the centerline of the roadbed, unless otherwise shown on the plans.

The flooring may be of random length and multiples of the stringer spacing with no single piece less than six (6) feet long. All splices shall be made on the centerline of a stringer and shall not occur oftener than once in six (6) inches on any one (1) stringer.

Laminations shall be laid with a finished edge down. Before laying, the tops of stringers shall be checked with a straightedge and adjacent stringers which vary more than one-eighth (1/8) inch from a true plane, except treated stringers, shall be surfaced to meet this requirement. Treated stringers which do not meet the requirements may be rejected but shall not be framed or adzed after treatment. Each piece of flooring shall be fastened to the preceding strip at each end and at approximately eighteen (18) inch intervals with spikes or nails driven alternately near the top and bottom edges. Spikes or nails shall be of sufficient length to pass through two (2) strips and at least halfway through the third strip. If timber supports are used, each piece shall be toe-nailed to every other support with 20d or 30d nails. Care shall be taken to have each strip vertical and tight against the preceding one, and bearing evenly on all supports.

507.03.13 Trusses. Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection, and vertical projection shall show a smooth curve through panel

points conforming to the correct camber. All bearing surfaces shall fit accurately. Uneven or rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.

Unless otherwise directed by the Engineer, housings and railings shall be built after the removal of the falsework and the adjustment of the trusses to correct alignment and camber.

507.03.14 Painting. Outside stringers, wheel guards, rails, rail posts, and exposed surfaces of scupper blocks, filler blocks, and flooring of untreated timber, or timber treated with preservative salts, shall be painted as specified in Section 614, "Painting."

Ends of all pieces of untreated timber not otherwise painted shall be painted with one (1) prime coat.

Metal parts, except hardware, shall be painted as specified in Section 614, "Painting," and given the number of coats specified in subsection 714.03.01, "Iron and Steel Use Items."

507.03.15 Timber Connectors. Timber connectors shall be one (1) of the following types, as specified on the plans: the split ring, the shear plate, or the spike grid. The split ring and the shear plate shall be installed in precut grooves of dimensions as given herein or as recommended by the manufacturer. The spike grid shall be forced into the contact surfaces of the timbers and joined by means of pressure equipment. All connectors of this type at a joint shall be embedded simultaneously and uniformly.

Fabrication of all structures using connectors shall be done prior to treatment. When prefabricated from templates or shop details, bolt holes shall not be more than one-sixteenth (1/16) inch from required placement. Bolt holes shall be one-sixteenth (1/16) inch larger than bolt diameter. Bolt holes shall be bored perpendicular to the face of the timber.

Connector grooves in timber shall be cut concentric with the bolt hole, shall conform to the cross-sectional shape of the rings, and shall provide a snug fit. Inside groove diameter shall be larger than nominal ring diameter in order that the ring will expand slightly during installation.

Timber after fabrication shall be stored in a manner that will prevent changes in the dimensions of the members before assembly.

Dimensions of material and details not otherwise specified shall meet with the approval of the Engineer.

METHOD OF MEASUREMENT

507.04.01 Measurement. The quantity of timber and lumber to be measured for payment will be the number of thousand feet board measure (Mfbm) conforming to all the requirements in the completed work.

All measurements will be in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

507.05.01 Payment. The accepted quantity of materials measured as provided in subsection 507.04.01, "Measurement," will be paid for at the contract unit price bid per thousand feet board measure (Mfbm).

The above prices shall be full compensation for furnishing all materials, including hardware, treating, erecting, and for all incidentals necessary for doing all the work involved, as shown on the plans or established by the Engineer, all in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Type Lumber	Mfbm

SECTION 508

PILING

DESCRIPTION

508.01.01 General. This work shall consist of furnishing and driving bearing piles of the kind, shape, and size called for in the contract documents. It includes timber piles, precast or cast in place concrete piles, sheet piling, and steel piles as described herein and is also applicable to other types of bearing piles if called for in the contract documents.

MATERIALS

508.02.01 General. Materials shall conform to the requirements of the following sections and subsections:

Steel Shell for Piles	Subsection 712.03.08
Steel Piles ("H" piles, sheet piling)	Subsection 712.03.07
Reinforcement	Section 713
Timber Piles	Section 717

Materials for concrete shall conform to the requirements of Section 501, "Portland Cement Concrete."

The Contractor shall furnish the Engineer with copies of mill test reports on the steel shells and steel piles.

CONSTRUCTION

508.03.01 Determination of Length. Bearing piles of any material shall be of such length as is required to develop the specified bearing value, to obtain the specified penetration, and to extend into the cap or footing block as indicated on the plans, after cutoff of any damaged portion.

The Contractor shall be responsible for furnishing piling of sufficient length to obtain the penetration and bearing value required. For the purpose of determining the lengths of the piles required, the Contractor, at his expense, may drive test piles, make borings, or make such other investigations as may be necessary.

508.03.02 Test Piles. Test piles furnished and driven by the Contractor for his use in determining the lengths of piles to be furnished may be so located that they may be cut off and become a part of the completed structure provided that such test piles conform to the requirements for piling as specified in these specifications.

Test piles which are designated in the contract documents shall conform to the requirements for piling as specified in these specifications and shall be so located that they may be cut off and become a part of the completed structure.

Test piles that are to become a part of the completed structure shall be driven with the same type of equipment that is to be used for driving foundation piles.

Test piles which are not to be incorporated in the completed structure shall be removed to at least two (2) feet below the surface of the ground and the remaining hole shall be backfilled with earth or other suitable material.

When piles are shown on the plans or specified in the special provisions to be load tested, such piles shall be load tested in accordance with the provisions in subsection 508.03.07, "Load Testing."

508.03.03 Equipment. The driving equipment shall be in good operating condition.

The size of hammer shall be selected to suit the conditions that will be encountered. It shall neither be so small that its energy will be largely dissipated in lost energy during driving nor so great that it will cause too rapid penetration and damage to the pile. If the size of the hammer used is found to be unsatisfactory, it shall be replaced with a larger or smaller hammer or other corrective measures shall be used as required to produce satisfactory results.

All piles shall be driven with either single or double acting steam, air, or diesel hammers.

Precast concrete piles shall be driven with a steam, air, or diesel hammer which shall develop an energy per blow at each full stroke of the piston of not less than one (1) foot-pound for each pound of weight driven.

For cast-in-place concrete piles where a mandrel is used in driving the shell, the total weight of the mandrel and the shell shall be considered as the weight of the pile and the hammer shall meet the same requirements as for precast concrete piles.

Hammers for driving H-bearing steel piles and steel shells for cast-in-place concrete piles, which are driven without mandrel, shall be steam, air, or diesel hammers of sufficient capacity to drive the pile or shell to the required penetration and bearing value without appreciable distortion or distress to the pile or shell.

Steam or air hammers shall be furnished with boiler or air capacity at least equal to that specified by the manufacturers of the hammers to be used. The boiler or compressor shall be equipped with an accurate pressure gauge at all times. The valve mechanism and other parts of the steam or air hammer shall be maintained in first-class condition so that the length of stroke and number of blows per minute for which the hammer is designed will be obtained. Inefficient steam or air hammers shall be removed from the work. When necessary to obtain the required penetration, the Contractor shall supply and operate at his own expense, single or double water jets and pumps or furnish the necessary drilling apparatus and drill holes not greater than the diameter of the pile to the proper depth and drive the piles therein. If a pile is set in a drilled hole, it shall be driven sufficiently to fix the point firmly and secure full bearing. Except as described in subsection 508.03.04, "Driving of Piles," jets or drills may be used only when so specified or ordered in writing by the Engineer.

Diesel-powered hammers may be used provided the required energy per blow, as specified for steam hammers, is delivered for the type of piling to be driven.

Driving leads shall be used and shall be constructed in such a manner as to afford freedom of movement of the hammer, and they shall be held in position by guys or stiff braces to insure support to the piles during driving. Except where piles are driven through water, the leads shall be of sufficient length so that the use of a follower will not be necessary.

508.03.04 Driving of Piles. Unless otherwise permitted by the Engineer, piles shall not be driven until after the excavation is completed. Any material forced up between the piles shall be removed to correct elevation before masonry for the foundation is placed.

Care shall be exercised to prevent damage to the piles due to overdriving.

Piles shall be driven battered (sloped) if called for on the plans.

Piles, other than sheet piles, shall not be driven until the approach fills are compacted and in place to an elevation of one and one-half (1½) feet above the bottom of the concrete abutment, as indicated on the plans. When piles are to be driven through embankment and the depth of the embankment at the pile location is in excess of five (5) feet, the pile (other than sheet pile) shall be driven in a hole drilled through the embankment. The hole shall have a diameter large enough to allow a minimum of two (2) inches clearance around the pile. After driving the pile, the space around the pile shall be filled to ground surface with dry sand or pea gravel.

When an abutment area is to be surcharged, piles shall not be driven therein until the surcharge has been in place the required period of time.

All piles raised during the process of driving adjacent piles shall be driven down again.

Unless otherwise ordered, inclined leads shall be used in driving battered piles.

An adequate cushion cap shall be used in driving precast concrete piles. When driving timber piles a cushion cap shall be used and not less than two (2) separate steel straps shall be placed within two (2) feet of the butt of each pile. Steel strapping shall conform to the requirements of AWPI specifications, except that the straps shall encircle the pile only once per strap. The top of the pile and the cap shall be so shaped that the blow of the hammer will be uniformly distributed to the entire top surface of the pile.

When load tests are required, piling shall not be driven until after test loading has been completed, except in case of service piles driven to serve as anchor piles for the test loading.

If the top of a pile becomes broomed, split, or crushed during the driving, the driving shall be stopped until the pile has been repaired or replaced by a new one.

The driving heads shall closely fit the top of the steel pile or shall extend down over the sides of the pile at least four (4) inches.

Piles shall be driven to the position and line indicated on the plans. Piles out of position and line more than the diameter of the pile, shall be pulled and replaced unless otherwise approved by the Engineer. When the tops of foundation piles are incorporated in a concrete footing, the distance from the side of any pile to the nearest edge of the footing shall not be less than nine (9) inches. Any additional materials required because of out-of-line piles that are allowed to remain in place will be at the expense of the Contractor.

508.03.05 Bearing Value and Penetration. (a) All pile driving equipment used by the Contractor shall be approved by the Engineer. Prerequisite to approval, the Contractor shall submit the following:

1. A completed pile and driving equipment data form (copy included in the special provisions) for each pile driving hammer proposed for the project.
2. A wave equation analysis performed by a professional engineer for each hammer at twice the design load (ultimate load) value shown on the plans.

(b) Notification of acceptance or rejection of the hammer by the Department shall be made to the Contractor within seven (7) days of receipt of data form and wave equation analysis. Acceptance of the hammer will be based on the following criteria determined from wave equation analysis:

1. At the proposed pile design tip length, the penetration rate to obtain ultimate load under-the-hammer bearing value is not less than one-tenth (0.1) foot for ten (10) blows.
2. The driving stress in the pile at ultimate load does not exceed the value shown on the plans.

(c) The Department shall conduct an independent wave equation analysis to:

1. Verify the Contractor's submission.
2. Develop driving criteria that relates an under-the-hammer bearing value to penetration rate. If the hammer is approved, the criteria will be used only for the accepted driving equipment. Any change in hammer make, model, or associated equipment in the driving system will require a resubmission for approval.

(d) Piles must penetrate below the minimum pile tip elevation shown on the plans. Drilling may be required to obtain minimum pile tip elevation, and if this is required, drilling shall be done in accordance with subsection 508.03.03, "Equipment."

(e) Below minimum tip, using Department developed pile driving criteria, piles shall be driven to an under-the-hammer bearing value equal to the ultimate load.

(f) If the ultimate load value is not reached at the design tip elevation shown on the plans, then the pile shall be left undisturbed for at least twenty-four (24) hours prior to further driving. The under-the-hammer bearing value will then be determined by the first ten (10) blows of the redrive.

508.03.06 Cut Off and Extensions. Timber piles which are to be capped shall be accurately cut off so that true bearing is obtained on every pile without use of shims. Other timber piles shall be cut off on the square at the elevation designated. Piles inaccurately cut off shall be replaced. Splicing of timber piles will not be permitted except upon the written permission of the Engineer. Concrete piles shall be cut off at such elevation that they will extend into the cap or footing as indicated on the plans. Concrete piles may be cast the full length of the reinforcing bars, providing that the concrete is cut off to expose the steel as shown on the plans after the piles have been driven. When it is necessary, after driving, to increase the length of precast concrete piles, concrete shall be removed to expose sufficient reinforcing steel to permit a lap of at least forty (40) diameters. The added length shall be sufficient to reach

the elevation of the bottom of the cap and shall be of the same section and the same reinforcement as the pile itself.

When the cut off elevation for precast concrete pile is below the elevation of the bottom of the cap, the pile shall be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced concrete extension constructed as shown on the plans.

The work of cutting off precast concrete piles shall be performed in such a manner as to avoid spalling or damaging the pile below the cut off. In case of such damage the pile shall be replaced or repaired as required by the Engineer.

All cut off lengths of piling shall remain the property of the Contractor and shall be disposed of outside the highway right of way in accordance with the provisions of subsection 107.14, "Disposal of Material Outside Highway Right of Way."

508.03.07 Load Testing. The number and location of the load tests shall be as noted on the plans or designated by the Engineer.

The Department will furnish all testing and jacking equipment, except the reaction system; however, the Contractor will be required to give the Department written notice at least seventy-two (72) hours in advance.

The Contractor shall furnish and assemble a suitable reaction system for each load test capable of sustaining a two hundred (200) ton test load without excessive deflection. This reaction system may utilize production piles and/or additional anchor piles or may be constructed as a total dead load reaction system. Additional piling required to match beam lengths, or cribbing and dead load material, shall be at the Contractor's option.

In addition to the above requirements, the reaction system shall meet the following minimum requirements:

(a) It shall be supported in such a manner that it is stable without support from the loading equipment.

(b) It shall be constructed in such a manner as to ensure that all structural elements in the system carry their intended proportion of the load, and any slack in the system is taken up before a fifty (50) ton test load is reached.

(c) It shall be so positioned that the test load can be applied axially on the test pile without any eccentricity.

Further, the Contractor shall submit detailed plans and design calculations for his proposed reaction system to the Engineer for approval.

If during the performance of any test any member or connection of the reaction system fails or is stressed beyond its yield point, or there is insufficient reaction to maintain the required load, the test shall be discontinued, and the Contractor shall correct any deficiencies in the system at his own expense before the test is restarted.

It shall also be the Contractor's responsibility to provide a smooth cut off surface on the test pile which is both planar and perpendicular to the longitudinal axis of the test pile. The Contractor shall also assist the Engineer in the placement of and the removal of the hydraulic jack to the test pile.

All other work of making and recording the test load will be performed by the Department. The "Quick Load Test" will be run in accordance with Test

Method No. Nev. T-600A, and the average time required to accomplish this test is expected to be about three (3) hours.

At any structure site where a load test is required and driven piles are specified, the penetration of all production piling for that structure shall be based upon the results of the load test(s), providing these pilings are driven with the same equipment and the resistance to driving (penetration per blow) is comparable. The Engineer shall make this determination and may require the Contractor to redrive any pile when necessary to assist him in this decision.

508.03.08 Timber Piles. The specie of timber used for timber piles shall be either Douglas Fir, Southern Yellow Pine, Larch, or Cedar as shown in the contract documents.

When treated piles are required they shall be given a preservative treatment of creosote by pressure processes to retain at least ten (10) pounds of creosote per cubic foot.

Timber piles shall conform to the requirements of Section 717, "Timber Piles," and shall be inspected as therein provided.

Commercially treated piles from stock may be used for test piles when required. Where commercially treated piles are permitted, stamping the piles by the inspector before treatment will not be required.

Treated timber piles shall be carefully handled during and after unloading from cars. They shall not be dragged across the ground at any time and shall be handled only with rope slings or with wooden equipment. Sharp tools shall be permitted only when used for necessary field cutting and trimming. All places where the surface of creosoted piling is broken by cutting, boring, or otherwise, shall be thoroughly coated with at least three (3) applications of hot creosote oil. Each application shall be allowed to become reasonably dry before the succeeding one is applied.

The piles in any one (1) bent shall be carefully selected as to size, to avoid undue bending or distortion of the sway bracing. However, care shall be exercised in the distribution of piles of varying sizes to secure uniform strength and rigidity in the bents of any given structure.

Heads of piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design.

When timber caps are specified, a coat of hot creosote oil shall be first applied to the head of the pile and a protective cap shall be built up by applying alternate layers of loosely woven fabric in a hot asphalt or tar using three (3) layers of asphalt or tar and two (2) layers of fabric. The fabric shall measure at least six (6) inches more in each direction than the diameter of the pile and shall be turned over the pile and the edges secured by binding with two (2) turns of No. 10 galvanized wire. The fabric shall be wired in advance of the application of the final coat of asphalt or tar which shall extend down over the wiring.

In lieu of the above method of treatment, the sawed surface may be covered with three (3) applications of a hot mixture of sixty (60) percent creosote oil and forty (40) percent roofing pitch, or thoroughly brush coated with three (3) applications of hot creosote oil and covered with hot roofing pitch. A covering

of galvanized sheet iron shall be placed over the pitch coating and bent down over the sides of the pile to shed water.

The method to be used shall be at the option of the Contractor unless otherwise provided on the plans or in the special provisions.

508.03.09 Precast Concrete Piles. Precast concrete piles shall be constructed of Class A or AA Portland cement concrete proportioned and mixed in accordance with the requirements of Section 501, "Portland Cement Concrete," and placed in accordance with Section 502, "Concrete Structures," of these specifications. Reinforcing steel shall conform to the requirements of Section 505, "Reinforcing Steel," of these specifications.

Concrete for precast concrete piles shall be poured in smooth watertight forms, so supported as to prevent appreciable deformation or settlement during pouring or curing. When removed from the form, the piles shall present true, smooth even surfaces free from honeycombs and voids and shall be such that a line stretched from butt to tip on any face will not be more than one (1) inch from the face of the pile at any point.

Concrete piles shall be kept continuously wet for at least ten (10) days after pouring and shall be allowed to harden for at least thirty (30) days before being lifted or driven, except that this thirty (30) day requirement may be decreased if the specimen of concrete from which the piles were poured develops a strength of three thousand (3,000) pounds or more per square inch of compression.

When raising or transporting precast concrete piles, the Contractor shall provide slings or other equipment to avoid any appreciable bending of the pile or cracking of the concrete. Piles materially damaged in handling or driving shall be replaced. Concrete piles shall be so handled at all times as to avoid breaking or chipping of the edges.

508.03.10 Cast-in-Place Concrete Piles. Concrete filling for cast-in-place concrete piles shall be Class A or AA Portland cement concrete conforming to the requirements of Section 501, "Portland Cement Concrete," of these specifications. Reinforcement shall conform with the details shown on the plans and the requirements of Section 505, "Reinforcing Steel." Cast-in-place concrete piles shall consist of one (1) of the following: Steel shells driven permanently to the required bearing value and filled with concrete or, drilled holes filled with concrete.

(a) Steel Shells. Steel shells shall be of sufficient strength and rigidity to permit their driving and to prevent distortion caused by soil pressures or the driving of adjacent piles until filled with concrete. The shells shall also be sufficiently watertight to exclude water during the placing of concrete.

The shells may be cylindrical or tapered, step tapered, or a combination of either with cylindrical sections. The tip diameter shall not be less than eight (8) inches and the butt diameter shall not be less than shown on the plans.

Shells to be driven without a mandrel shall be equipped with heavy steel driving ends and all joints in the shell shall be welded or adequately lock seamed.

After being driven and prior to placing concrete and reinforcing steel therein, the steel shells or casings shall be examined for collapse or reduced

diameter at any point. Any shell or casing that is improperly driven or broken or shows partial collapse to such an extent as to materially decrease its bearing value will not be accepted and shall be replaced by the Contractor at his own expense. Driven shells or casings shall be clean and free from water before concrete and reinforcing steel are placed. The Contractor shall have available at all times a suitable light for the inspection of the shells, throughout the entire length, before they are filled with concrete and reinforcing steel.

Concrete shall be placed in steel shells so that it is dense and homogeneous. The upper portion of the shell shall be vibrated to a depth of not less than one-third (1/3) the length of the pile or ten (10) feet, whichever is the greater.

The length of steel shell to be ordered shall be determined by the Contractor. Should the Contractor elect to order piling in short lengths, all splices necessary to build up these shorter lengths to the length required, other than those splices specified for payment in subsection 508.04.01 of these specifications, shall be at the Contractor's expense.

(b) Drilled Holes. This work shall govern the construction of "cast-in-drilled hole" concrete piles. Piles shall be of a concrete section, cast-in-place against in-situ-soil and shall be reinforced as shown on the plans.

Ground and Surface Water. The water table elevations indicated on the test boring logs are those existing on the dates and at the boring locations as noted on the plans.

Drilled Shaft Inspection Report. The Contractor shall provide any assistance that may be required for the Engineer to prepare and submit daily reports for the complete drilled shaft construction program. The reports will include: logging all excavated soils, concrete quantities, recording actual elevations at top and bottom of each drilled shaft, elevation of rock (if any), plumbness of casing and rebar cages, seepage of water, elevation of top and bottom of any casing left in place, any unusual conditions, and any other pertinent information deemed necessary.

Pile Locations, Alignment, and Tolerances. The drilled shafts shall be constructed such that the axis of the shaft, at the top, is no more than two (2) inches from its plan location. Drilled shafts shall be within one and one-half (1½) percent of the plumb deviation for the total length of the pile and shall not exceed twelve and one-half (12½) percent of the shaft diameter or fifteen (15) inches, whichever is less. The plumbness of the drilled shaft shall be measured by an accurate probing procedure, inclinometer in the Kelly bar or other techniques that may be approved by the Engineer.

When temporary starter casing or a vibrated casing is extracted, a short collar form shall be placed at the top of the drilled portion of the shaft such that diameter tolerances can be achieved.

Excavation. Straight, drilled shafts shall be advanced with flight or bucket augers or with other approved drilling tools capable of drilling soil, cobbles, boulders, rock, or whatever materials encountered, to the dimensions and elevations shown on the plans. The plans indicate the expected depths and elevation where satisfactory bearing material will be encountered. If satisfactory material is not encountered at plan elevation, the bottom of the shaft may be lowered only as approved by the Engineer.

Caving of the drilled holes shall be prevented at all times during pile construction by use of steel casing or other procedures as approved by the

Engineer. Drilling equipment shall be constructed and operated so that free passage of fluids is provided around the drilling head during its insertion and removal from the hole to the extent that scouring or caving will not occur.

If steel casing is utilized to prevent sloughing, said casing shall be smooth metal and of ample strength to withstand handling stresses, the pressure of concrete, surrounding earth, or backfill materials and shall be watertight. The outside diameter of the casing shall be less than the specified size of the shafts.

If a casing is used, its removal shall not be started until the level of concrete within the casing is at least five (5) feet above the bottom of the casing. Movement of the casing for short pulls of a few inches, exerting downward pressure, hammering, and vibrating the casing will be permitted to facilitate extraction and to avoid separation of the concrete. When casing is used, its extraction must be done so that the concrete cast against the surrounding soil will develop the designed skin friction. No casing extraction will be allowed after two (2) hours from the concrete batch time unless a retarding agent is used. When a retarder is used, this two (2) hour period may be extended provided that no concrete achieves an initial set. Casing not extracted within the allotted time shall remain in the excavation.

Drilling without the use of casing may be allowed as follows: (1) above the water table; and (2) below the water table only if the foundation Contractor can conclusively prove with a full-depth, design diameter test shaft, that such procedures are applicable at this site, and that all of the tolerances and design criteria detailed in the plans and within these specifications for drilled pile foundations can be adhered to. This test shaft shall not be incorporated into the foundation and shall be filled to ground line with pea gravel. No payment will be made for the test shaft or any other items incidental to the dry hole or uncased drilling.

Regardless of construction method used, the bottom of the excavation shall be cleaned of loose material, by using a bucket auger or any other technique approved by the Engineer. After cleaning, a probe shall be lowered to the base of the drilled shaft to insure that cleaning has been satisfactorily completed. An accumulation of loose soils, muck, etc., at the bottom of the excavation shall not be allowed. Material excavated from the shaft shall be utilized as provided in the last paragraph of subsection 206.03.01 of these specifications or disposed of in accordance with subsection 107.14 of the specifications.

After completion of shaft excavation and prior to placement of reinforcing steel and concrete, the proper condition of the excavated shaft will be verified by the Engineer. The Contractor shall measure the shaft dimensions, determine the plumb deviation of the shaft, and produce such information for the "Shaft Inspection Report."

Reinforcing Steel. Reinforcing steel shall conform to the requirements of Section 505, "Reinforcing Steel," and the plans. The cage of reinforcing steel, consisting of longitudinal bars, spiral and any temporary bar braces shall be completely assembled and placed in the drilled shaft at a unit upon completion of drilling and immediately prior to concrete placement. If concrete placement does not follow immediately after cage placement, the steel must be removed from the shaft and the integrity of the excavation recertified prior to reinstallation of the cage.

The rebar cage shall be supported from the top by a ground surface frame, crane, or other positive means, during complete concrete placement, in order to insure cage plumbness and to minimize downward slumping. The support system shall be concentric with the cage to prevent racking and distortion of the steel. Every effort shall be made to keep the cage plumb during casing extraction.

To insure adequate concrete cover and achieve concentric spacing of the entire length of the cage within the shaft, three (3) inch (minimum) thick concrete spacer blocks shall be securely tied at 5th points around the cage perimeter. The blocks shall span two (2) adjacent vertical bars or horizontal ties such that rotation will not occur. Block locations shall start at the bottom of the cage and continue up along its length at spacing no greater than ten (10) feet. Additional peripheral blocks and closer intervals may be required as determined by conditions in the field.

Placement of Concrete. Concrete shall be placed as soon as possible after all excavation is complete and immediately after the reinforcing steel is placed. Prior to placing concrete, the bottom of the excavation shall be cleaned and free of all loose material, as specified above. Concrete shall be placed only by pumping through a tremie pipe. No free fall of the concrete will be allowed. The tremie pipe shall be of a rigid watertight pipe for the full length of the shaft and shall not be less than five (5) inches inside diameter. Jointless solid pipe is recommended. The pipe shall be equipped with a bottom valve, or other approved device, which would prevent mixing of slurry or other contaminants with the concrete inside the pipe.

The Contractor shall be required to have on site, or make provisions for, a second (backup) pump to be available during the concreting operations. Reinforcing steel shall be in place and the tremie pipe inserted to the bottom of the drilled shaft before concrete placement is started. The pump shall be properly primed and the concrete shall be placed in a continuous operation in such a manner that the concrete always flows upward within the hole. The delivery pipe shall be slowly withdrawn as the elevation of the concrete in the hole rises, but the discharge end of the pipe shall, at all times, be maintained at least five (5) feet and not more than ten (10) feet below the surface of the concrete. This five (5) to ten (10) foot range may be assured by the use of a fixed tremie pipe float device. During concrete placement the Contractor shall provide and maintain markings on the tremie pipe, a sounding device, or other adequate methods in which to determine the relative elevation of the concrete surface and the end of the tremie pipe. Raising of the tremie pipe shall be done only when the pipe contains a sufficient head of concrete to prevent the formation of a void at the tip and as approved by the Engineer. A predetermined plan shall be formulated between the Contractor's job foreman and the pump operator concerning how and when an order will be given to lift the tremie pipe.

Concrete delivery into the shaft shall continue until the discharge at the top of the pile is free of water, soil, and debris, and uncontaminated concrete extends to the cut off elevation. Should a delay occur because of concrete delivery or other factors, the rate of placement for concrete shall be reduced so as to maintain some movement of the concrete. The procedures employed shall be such that the concrete within the shaft consists of a monolithic

homogeneous structure. In uncased piles, concrete shall not be vibrated during placement, except from the bottom of the reinforcing cage to the top of the pile. If casing is utilized, vibration shall take place during withdrawal of the last fifteen (15) feet of the casing and shall stay below the bottom of the casing as it is removed. Where steel liners or casings have been used to support the excavation walls, the liners shall be withdrawn as the concrete is being placed within the limits previously specified elsewhere in these specifications. The steel liner shall be removed in a manner so that the lower edge of the steel liner shall always remain a minimum of five (5) feet below the surface of the concrete as placed to prevent water or soil from entering the shaft excavation from below the bottom of the casing. The Contractor shall submit to the Engineer for approval appropriate procedures and methods of withdrawal of steel liners to ensure that the concrete is not being lifted as the steel liner is being withdrawn.

The elevation of the top of the steel cage and the surface of the concrete shall be carefully checked before and after casing extraction. Any upward or downward movement of the steel exceeding two (2) inches or any downward movement of the concrete may be cause for rejection.

The top surface of the pile shall be cured as prescribed in subsection 501.03.09 of these specifications.

Scheduling and Restrictions. After the first pile has been successfully constructed, no significant change shall be made in construction methods, equipment, or materials to be used in the construction of such piles unless approved by the Engineer. The first pile must be approved prior to proceeding with additional piles. Drilling may commence on a subsequent pile at an approved location provided that the concrete operation on the previously drilled shaft is in progress and the manpower is adequate to cover all required operations.

Drilling and concrete placement should be scheduled so that each pile is placed immediately after drilling is completed and reinforcing steel accurately placed and approved.

For a period of at least twenty-four (24) hours after pile concrete has been placed, no adjacent pile shall be drilled, no excessive wheel loads shall be allowed, and no vibration shall be allowed to occur or be felt at any point within five (5) feet from the periphery of the pile.

In the event that the Contractor fails to satisfactorily perform the procedures described within, the Engineer may shut down the construction operation and/or reject the pile. If the integrity of the pile is in question, core drilling, sonic, or other approved methods shall be employed by the Contractor at his expense, under the direction of the Engineer. Core-drilled holes will be backfilled with grout or mortar. Any remedial measures will be directed and approved by the Engineer. No compensation will be due the Contractor for losses or damages due to remedial work or any testing required on piles found defective or not in accordance with the requirements of the plans and these specifications.

The footings of pier columns shall not be cast on the frilled piles until at least seven (7) days have elapsed, or fifty (50) percent of the compressive strength is obtained.

Inspection, Supervision, and Records. The Contractor will be required to provide full construction supervision and maintain accurate records during all phases of the drilled shaft operation.

508.03.11 Steel Piles. Steel piles shall be H-bearing of the section shown on the plans.

The length of steel pile may be built up in sections either before or during the driving operations. The sections, unless otherwise shown on the plans, shall be identical in cross section. The connections shall be made by welding the entire cross section in conformance with the requirements of subsection 506.03.20, "Welding." Care shall be taken to properly align the sections connected so that axis of the pile will be straight. The number of welded connections in the length of the pile shall be as few as practicable. If a welded splice is made during the driving operation, it shall be done when the top of the lower portion is at least three (3) feet above the ground to permit observation of the welded connection during several feet of driving.

Piling built up from structural steel plates welded together may be substituted for the rolled steel piling shown on the plans provided that the depth, width, average mean thicknesses, and moments of inertia of the built-up sections are at least equal to those of the rolled section and the flanges are welded to the web with continuous fillet welds on each side of the web and the welding conforms to Section 506, "Steel Structures."

Commercially prefabricated pile splices may be used when approved by the Engineer.

METHOD OF MEASUREMENT

508.04.01 Measurements. The quantity of "Furnish (type) Piles" to be measured for payment will be the number of linear feet of (type) pile complete and in place measured from the tip of the pile to the plane of pile cutoff.

The quantity of "Driving (type) Piles" to be measured for payment will be the number of piles driven complete in place.

"Redrive Piles" shall be measured for payment on a force account basis in accordance with subsection 109.03, "Extra and Force Account Work."

If the Contractor casts concrete piles full length of the reinforcement bars to facilitate driving, no measurement will be made for the portion where concrete must be removed in order that bars may project as shown on the plans.

Load tests will be measured for each and the number used in the work will be the number paid for.

The quantity of splices to be measured for payment will be limited to the number required to splice the pile if it becomes necessary to drive beyond "Design Pile Tip Penetration." Length of extensions will be determined by the Engineer. All splices necessary to drive to "Design Pile Tip Penetration" and for extensions made of shorter lengths than ordered by the Engineer will be at the Contractor's expense.

Metal pile shells driven with a removable core or mandrel shall be spliced according to the manufacturer's specifications. No splices will be measured and paid for when thin shell piles are used that do not require complete circumferential welding performed in the field.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

508.05.01 Payment. The accepted quantity of "Furnish (type) Piles," measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot, which price shall be full compensation for furnishing all materials including Portland cement concrete, steel shells and reinforcing steel, placing filling materials, and disposing of all unused material.

The accepted quantity of "Driving (type) Piles" measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per each, which price shall be full compensation for doing all the work involved in driving, drilling holes, cutting off piles, excavation and backfill, and for filling the space around the pile with sand or pea gravel; all to the required bearing and penetration as shown on the plans or ordered by the Engineer.

Payment for "Redrive Piles," measured as provided in subsection 508.04.01, "Measurement," will be paid for by force account except the force account method of payment for labor and equipment required to redrive piles shall be restricted to the labor and equipment on the jobsite. Force account will not be paid to import labor and equipment from areas outside the project limits.

The cost of furnishing, moving (except moving required to redrive piles), and removing equipment for driving piles on the job shall be considered as included in the lump sum price bid for "Mobilization" and no further compensation will be allowed therefor.

When brackets or plates are required on the plans for pile tip reinforcement for steel piles or special driving shoes for timber piles, the Contractor shall furnish and place such devices and all costs involved shall be considered included in the contract unit price bid per linear foot for "Furnish (type) Piles."

Test piles that become a part of the completed structure will be paid for at the contract prices for the type of piling used.

No payment will be made for piles driven out of place, for imperfect piles, or for piles which are damaged in handling or driving.

When, in addition to the requirements of the plans and specifications, brackets or plates are required on steel piles, or special driving shoes are required on timber piles, the Contractor shall furnish and place such devices and the cost thereof will be paid for as extra work as provided in subsection 104.03, "Extra Work."

The accepted quantity of load tests measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per each for "Quick Load Test," which price shall be full compensation for all material, equipment, tools, and labor involved in furnishing, placing, and moving the reaction system from place to place as well as conditioning the test pile ready for the test and removing the reaction system at the completion of the test, all as required by the Engineer.

The accepted quantity of splices measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per each for the splice, which price shall be full compensation for all material, equipment, tools, and labor incidental to make the splice.

Where piling built up from structural steel plates is substituted for the piling specified on the plans, the Contractor shall be entitled to no extra compensation for any excess thickness of steel furnished or for any extra work, materials, equipment, handling, or treatment required to construct such piling.

The accepted quantity of "Furnish Cast in Drilled Hole Concrete Piles," measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot, which price shall be full compensation for drilling holes for piling and disposing of material resulting therefrom, and for furnishing and placing all materials including Portland cement concrete and reinforcing steel and for doing all the work necessary to install the piling complete and in place as shown on the plans and as directed by the Engineer.

The contract unit price bid per linear foot for "Furnishing Cast in Drilled Hole Concrete Piles" shall also include all casing, bracing, concrete overages, test shaft, and any other items or incidentals necessary to install the piles complete in place.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Furnish (type) Piles	Linear Foot
Drive (type) Piles	Linear Foot
Redrive Piles	Force Account
Quick Load Test	Each
Splices	Each

SECTION 600

PIPE CULVERTS—TYPE OF MATERIAL OPTIONAL

DESCRIPTION

600.01.01 General. This work shall consist of furnishing and installing either full circle corrugated steel, corrugated aluminum, corrugated polyethylene, or reinforced concrete pipe and end sections. Any of the four (4) alternate types of pipe may be used at the location where it is indicated on the plans that "(size) Culvert Pipe" and "(size) End Section" are acceptable, except that the maximum size of polyethylene pipe shall be limited to twenty-four (24) inches in diameter.

The type of pipe and end sections furnished at an individual location shall be the same materials, except that polyethylene pipe shall be connected to metal end sections only. The connection shall be made in accordance with the polyethylene pipe manufacturer's recommendations.

Two (2) weeks in advance of the preconstruction conference, the Contractor shall submit to the Engineer, in writing, the type of culvert pipe he will furnish. Once a choice has been made, the Contractor shall not be allowed to change the type of culvert material chosen.

As hereinafter stated, the culvert pipe design governed by this section of these specifications has by necessity been based on one (1) basic type and configuration of material. Should the Contractor elect to furnish other materials as herein provided, it shall be his responsibility to furnish the Engineer a detailed listing of each culvert installation so affected. The listing shall include but not be limited to the following:

(a) Location.

(b) Alternate chosen, including type metal, gage, size corrugations, class of concrete pipe, and end section(s) to be furnished.

All design features, quantities, etc., under this section of these specifications are based upon corrugated steel pipe, two and two-thirds ($2\frac{2}{3}$) inch by one-half ($\frac{1}{2}$) inch corrugations and gages are to be determined based on the design fill height and using the appropriate fill height table as shown on the plans. Should the Contractor elect to furnish corrugated steel with three (3) by one (1) or five (5) by one (1) inch corrugations, or aluminum pipe, the gages shall be adjusted to comply with the appropriate fill height table shown on the plans for the size corrugation and type of material chosen using said design fill height. Should the Contractor elect to furnish reinforced concrete pipe, the class of concrete pipe shall be based upon the fill height table for concrete pipe and the design fill height shown on the plans.

MATERIALS

600.02.01 General. The materials used shall be those prescribed or used for the several items which constitute the finished work and shall conform to the requirements in the following sections or subsections:

Pipe Culverts—General.....Section 601
Reinforced Concrete Pipe.....Section 603
Corrugated Metal Pipe and Metal Arch Pipe.....Section 604
Aluminum Corrugated Metal Pipe and Aluminum Arch Culverts.....Section 605
Corrugated Polyethylene Pipe.....Subsection 708.03.07

Note: Alternate materials for arch pipe or culverts are not included in this section nor will they be allowed.

CONSTRUCTION

600.03.01 General. This work shall be governed by the type of pipe the Contractor elects to furnish and install. Therefor, the applicable portions of Sections 601, 603, 604, and 605 of these specifications shall apply.

Polyethylene pipe sections shall be joined by snap couplers, split couplers, or spin-on couplers as recommended by the manufacturer.

METHOD OF MEASUREMENT

600.04.01 Measurement. Quantities shown on the plans are based on corrugated metal pipe. There shall be no adjustment of said quantities due to the Contractor's choice of materials.

Except as provided above, measurement shall conform to the requirements of subsection 601.04.01 of these specifications.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

600.05.01 Payment. The items, measured as provided above, shall be paid for at the contract unit price bid per linear foot for "(size) Culvert Pipe" and per each for "(size) End Section."

The above prices shall be considered full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals and for doing all the work involved in furnishing and installing the culvert complete in place as herein specified, except that structure excavation and granular backfill will be paid for in accordance with the quantity required for the installation of corrugated metal pipe regardless of the type of pipe installed.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Culvert Pipe	Linear Foot
(size) End Section	Each

SECTION 601

PIPE CULVERTS—GENERAL

DESCRIPTION

601.01.01 General. These specifications include general requirements that are applicable to all type culvert pipes except structural plate pipe, irrespective of the material or culvert use.

This work shall consist of furnishing and installing pipe culverts, siphons, end sections, end walls, etc., as may be required to complete the work shown on the plans or established by the Engineer.

MATERIALS

601.02.01 General. The materials used shall be those prescribed or used for the several items which constitute the finished work and shall conform to the requirements in the following subsections:

Corrugated Metal Pipe and Pipe Arches	Subsection 709.03.01
Bituminous Coated Corrugated Metal Pipe and Pipe Arches	Subsection 709.03.02
Corrugated Aluminum Pipe	Subsection 709.03.03
Reinforced Concrete Pipe	Subsection 708.03.01
Nonreinforced Concrete Pipe	Subsection 708.03.02
Clay Pipe	Subsection 708.03.04
Grout and Mortar Sand	Subsection 706.03.04
Rubber Gaskets	Subsection 707.03.02

When the location of manufacturing plants allows, the plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for compliance with materials quality requirements. This can be the basis for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.

The lengths shown on the plans are approximate. The Contractor shall not order and deliver the culvert pipe until a correct list of sizes and lengths is furnished him by the Engineer.

For structural plate pipe and arches, attention is directed to Section 606, "Structural Plate Pipe, Pipe Arch, and Arch Culverts."

The ends of helically formed steel or aluminum pipe having a diameter of twelve (12) inches and greater and which must be field jointed shall have reformed annular ends and shall be connected with annularly formed connecting bands. Helically formed pipe having a diameter of less than twelve (12) inches which must be field jointed shall be connected with any of the appropriate coupling bands shown on Standard Plan Sheet No. R-2.8.1-(604) and all joints shall be properly gasketed as recommended by the manufacturer of the pipe.

CONSTRUCTION

601.03.01 Earthwork. Excavation and backfill shall conform to the requirements of Sections 206, "Structure Excavation," and 207, "Backfill."

The pipe shall be bedded as shown in the standard sheets appended to the plans. When no bedding class is specified, the requirements for Class C bedding shall apply. The lines and grades will be established by the Engineer.

Where pipes are to be installed in new embankments on a steep slope or in a difficult location, the height of new embankments may be varied as directed by the Engineer before installing pipes.

When headwalls are not required and granular materials are used for backfilling, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure in well tamped clay as directed by the Engineer.

601.03.02 Headwalls. Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with culvert pipes. Where such headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the Engineer. Headwalls are to be constructed to conform to the applicable requirements of Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures."

601.03.03 End Sections. The bed for the end section shall be excavated to the required width and grade. For metal end sections with toe plates, a trench shall be excavated for the toe plate in a manner to permit the toe plate being against the inner face of the trench when the end section is in its final position. After end sections have been properly secured to the pipe, this trench shall be backfilled and firmly compacted.

Precast concrete end section shall be placed with its tongue (or groove) fully entered in the groove (or tongue) of the pipe.

601.03.04 Jacked Pipes. Culvert pipe to be jacked in place between the limits shown on the plans shall conform to the requirements of the respective section of pipe culverts.

The strength of pipe or gage of pipe will be determined for vertical load only. Any additional reinforcement or strength required to withstand jacking pressure shall be determined and furnished by the Contractor at his expense.

Variation from theoretical alignment and grade at the time of completion of placing shall not exceed two-tenths (0.2) foot for each twenty (20) feet of pipe placed.

The diameter of the excavated hole shall not be more than one-tenth (0.1) foot greater than the outside diameter of the pipe. Sluicing and jetting with water will not be permitted. When the material tends to cave in from outside these limits a shield shall be used ahead of the first section of pipe or the face of excavation shall not extend beyond the end of the pipe greater than one and one-half (1½) feet unless permitted by the Engineer.

Areas resulting from caving or excavating outside the above limits shall be backfilled with sand or grout by a method which will fill the voids.

601.03.05 Laying Culvert Pipe. Laying of culvert pipe shall conform to the requirements of the respective sections of culvert pipe.

601.03.06 Extending Existing Culverts. Where shown on the plans or directed by the Engineer, existing culverts shall be extended in accordance with the provisions for installing new culverts and the following additional provisions.

Existing headwalls shall be demolished and removed and disposed of or moved to the extended location as indicated on the plans or ordered by the Engineer. Attention is directed to Section 202, "Removal of Structures and Obstructions."

A headwall that is not to be reset shall be demolished without injury to the existing culvert and removed and disposed of in accordance with the provisions of Section 202, "Removal of Structures and Obstructions." If shown on the plans or ordered by the Engineer, a new concrete headwall shall be constructed in accordance with the provisions of Section 501, "Portland Cement Concrete," of these specifications, or a flared end section shall be attached thereto. In the event the existing pipe is damaged during headwall removal, the pipe shall be repaired or replaced as directed by the Engineer. Said repair or replacement shall be at the Contractor's expense and no additional compensation shall be allowed therefor.

METHOD OF MEASUREMENT

601.04.01 Measurement. The materials to be paid for under these specifications will be listed in the contract items by size, class, type gage, or whatever information is necessary for identification.

The quantity of culvert pipe to be measured for payment will be the actual number of linear feet of pipe including the stub on end sections, complete and in place. When pipes are cut to fit a structure or slope, the quantity to be paid for will be the length of pipe necessary to be placed before cutting, measured in even two (2) foot increments.

Attention is especially directed to plan sheets titled "Standard Details—Structure Excavation and Backfill—Method of Measurement," which shall pertain.

Culvert pipe bends, wyes, tees, and other branches will be measured and paid for by the linear foot for the sizes of pipes involved. Wyes, tees, eccentric reducers, and other branches will be measured along centerlines to the point of intersection.

Structure excavation and structure backfill, Portland cement concrete and reinforcement required for headwalls, endwalls, structures, and other items of work required by the plans and special provisions to complete the work, will be measured and paid for as separate items as provided for under their respective sections of these specifications, or the contract documents. Structure excavation and backfill will not be measured for payment on preformed end sections.

No separate measurement or payment will be made for constructing jacking pits and backfilling all pits after the pipe is jacked, nor for excavation and backfill between the limits shown on the plans for jacking the pipe. Full

compensation therefor will be considered as included in the price paid for jacked pipe.

Culvert pipe to be placed outside the limits for jacked pipe shall conform to the requirements of the respective section of pipe culverts. The limits for payment of structure excavation and backfill will be the original ground line before jacking pits are excavated.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

601.05.01 Payment. The accepted quantities of culvert pipe measured as specified in subsection 601.04.01, "Measurement," will be listed under the respective sections of pipe culverts.

When any of the various sizes, types, and gages of pipe are installed by the jacking method, the contract price paid per linear foot for jacked pipe shall include full compensation for furnishing the pipe, excavating, jacking, furnishing and placing backfill material, and all incidentals for doing all the work involved in jacking the pipe, as specified.

Full compensation for furnishing pipe with end finish, including distortion if required, will be considered as included in the price paid per linear foot for the pipe involved and no additional compensation will be allowed therefor. Full compensation for Class B and Class C bedding will be considered included in the price paid per cubic yard for backfill or granular backfill as the case may be and such payment shall include compensation for all the materials, labor, tools, and incidentals necessary to complete the work.

Class A bedding will be paid for at the contract unit bid price per cubic yard for Class C or CA concrete. When Class C or CA concrete is not an item on the bid schedule, Class A bedding will be paid for at the contract unit bid price per cubic yard for Class A or Class AA concrete. Payment as stated above shall be full compensation for all the materials, labor, tools, and incidentals necessary to complete the work.

Provisions for handling of whatever water may be encountered at the site shall be an obligation of the Contractor and payment therefor shall be considered as subsidiary to the items involved and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

SECTION 602

NONREINFORCED CONCRETE AND CLAY PIPE

DESCRIPTION

602.01.01 General. This work shall consist of furnishing and installing nonreinforced concrete pipe or clay culvert pipe of the kind, sizes, and dimensions shown on the plans or established by the Engineer and in accordance with the requirements of these specifications.

MATERIALS

602.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 603.02.01 of Section 603, "Reinforced Concrete Pipe," and subsection 601.02.01 of Section 601, "Pipe Culverts—General."

CONSTRUCTION

602.03.01 General. The construction requirements shall be as prescribed in subsections 603.03.01 through 603.03.06 of Section 603, "Reinforced Concrete Pipe," with the following modifications:

(a) External bands of mortar shall be placed around the pipe joints as herein specified. Several sections of pipe shall be joined before commencing banding operations, but the placing of external bands shall never be more than five (5) lengths of pipe behind joining operations.

Immediately in advance of placing external band mortar, the external surface of the pipe sections at the joint shall be thoroughly cleaned and wetted to insure proper bonding of the band mortar with the pipe. Care shall be exercised to make a union between the band and the mortar which was placed under the joint before the pipe sections were abutted. The band shall not be less than three-eighths (3/8) inch thick at the pipe joint and shall be approximately four (4) inches wide, overlapping the abutting ends of the pipe sections approximately two (2) inches. The edges of the band shall adhere to the pipe surface to prevent peeling and shall be finished in a workmanlike manner.

(b) When irrigation or sewer pipe is placed beyond the limits of roadway excavation or embankment, the initial covering of backfill material shall be fine earth or sand approved by the Engineer. Placing the remainder of the trench backfill in layers and compacting to a relative compaction of ninety (90) percent will not be required.

(c) Openings shall be cut into irrigation or sewer pipe and connections made thereto as shown on the plans or directed by the Engineer.

Openings shall be cut to proper sizes. Connections shall be cut to fit closely and shall be strongly cemented to the pipe with banding mortar. In all cases, the area of pipe where the connection is made shall be clean and wet when the mortar is applied.

METHOD OF MEASUREMENT

602.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement," with the exception that backfill will not be measured for payment when placed beyond the limits of roadway excavation or embankment.

BASIS OF PAYMENT

602.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of nonreinforced concrete or clay pipe will be paid for at the contract bid price per linear foot for the types and sizes specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Nonreinforced Concrete Pipe (type)	Linear Foot
(size) Clay Pipe (type)	Linear Foot

SECTION 603

REINFORCED CONCRETE PIPE

DESCRIPTION

603.01.01 General. This work shall consist of furnishing and installing circular or oval shaped reinforced concrete pipe, siphons, and conduits of the size, kinds, and dimensions and at locations shown on the plans or established by the Engineer and in accordance with the requirements of these specifications.

MATERIALS

603.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 601.02.01 of Section 601, "Pipe Culverts—General," and in addition thereto, the following requirements shall apply.

Circular reinforced concrete pipe shall conform to the specifications of AASHTO Designation M170 for the specified diameters and strength classes.

Oval reinforced concrete pipe shall conform to the specifications of AASHTO Designation M207 for the specified span and rise for either horizontal or vertical elliptical pipe classes.

Oval shaped pipe, within the meaning of these specifications, shall be pipe having major and minor internal axial dimensions as designated in the contract item. The length of the minor axis shall be between sixty (60) percent and sixty-five (65) percent of the length of the major axis. The first dimension designated will represent the axis that is to be placed horizontally and the second dimension will represent the vertical axis. The dimension, in feet, of the horizontal axis shall be the basis for calculating the strength of the pipe. The inside perimeter of oval pipes shall form either an ellipse, or an approximation thereof, as described by smooth, compounded circular arcs.

Flared end sections (precast) shall conform to the details and dimensions shown on the plans and, except for shape, shall conform to the requirements of this section for reinforced concrete pipe.

Concrete pipe shall be carefully handled in unloading, transporting, and laying.

No pipe shall be laid which is cracked, checked, spalled, or damaged, and all such sections of pipe shall be permanently removed from the work. Pipes which show defects due to handling shall be rejected at the site of the installation regardless of prior acceptance.

Rubber gaskets shall conform to the requirements of subsection 707.03.02, "Rubber Gaskets."

Joint mortar shall be composed of one (1) part Portland cement and two (2) parts sand by volume.

Sand shall conform to the requirements of subsection 706.03.04, "Grout and Mortar Sand," of these specifications.

The materials shall be mixed to a consistency suitable for the purpose intended. All mortar shall be used within thirty (30) minutes after the mixing water has been added.

Admixtures of hydrated lime, fire clay, diatomaceous earth, or other approved inert material may be used in the mortar to facilitate workability if the Contractor elects. The amount of admixture to be added shall be the quantity permitted by the Engineer.

CONSTRUCTION

603.03.01 General. Construction methods shall conform to the requirements of subsections 601.03.01 through 601.03.06 of Section 601, "Pipe Culverts—General," and in addition thereto, shall meet the following requirements.

603.03.02 Earthwork. Where pipes are to be installed in new embankment (projection), the embankment shall first be constructed to the required elevation as set forth in the following Methods "A" or "B." Method "A" shall be followed unless otherwise specified in the contract documents, and with the further exception that when the pipe is to be installed on a steep slope or at a difficult location, the height of embankment to be constructed in advance of installing the pipe may be varied when permitted by the Engineer.

Method A

In the case of pipes twenty-four (24) inches or less in diameter the roadway embankment shall be constructed to an elevation of six (6) inches above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

In the case of pipes more than twenty-four (24) inches in diameter the roadway embankment shall be constructed to an elevation of thirty (30) inches above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

Method B

The new embankment shall be constructed and compacted to an elevation above the top of the pipe equal to the external diameter of the pipe plus one (1) foot and to a width each side of the pipe of not less than five (5) times the diameter of the pipe. The trench shall then be excavated to the bottom of the pipe and to a width of the inside diameter plus three (3) feet.

After the pipe has been installed, backfill shall be placed in the trench to an elevation one (1) foot above the top of the pipe. Backfill to be placed in accordance with the requirements of Section 207, "Backfill." The lower one-third (1/3) of the remaining trench shall then be filled with loose straw, hay, brush, sawdust, or other highly compressible material and the remainder of the trench shall then be filled in a normal manner. The embankment may then be constructed in the normal manner.

When pipe having bells or hubs is used, cross trenches shall be excavated for them to prevent nonuniform loading of the joints. The cross trenches shall not be more than two (2) inches wider than the width of the bell or hub.

603.03.03 Laying Culvert Pipe. The Contractor shall determine his source of supply of sand for use in mortar a sufficient time in advance of pipe

laying operations to permit sampling and testing before use, and no mortar shall be used until the sand has been approved by the Engineer.

The consistency of joining mortar shall be such as to adhere to the ends of the pipe while being laid and may be easily squeezed out of the joint when the pipe sections are pressed together.

In advance of joining sections of pipe, the ends of each section shall be washed clean with a wet brush and immediately prior to placing mortar and joining the sections, the ends shall be thoroughly wetted.

Pipe sections shall be checked for alignment and grade at the time of joining the sections. If an adjustment in alignment or grade is necessary after making the joint, additional mortar shall be firmly pressed into the joint, and in the case of pipes less than twenty-four (24) inches in diameter, the internal and external surfaces of the joints shall be brushed.

The interior of the pipe shall be kept free of dirt, excess mortar, and other foreign material as the pipe laying progresses, and left clean at the completion of the work. Any pipe which is not in true alignment or which shows any undue settlement after laying, or is damaged, shall be taken up and relaid at the Contractor's expense.

The first section of pipe to be laid shall be firmly placed to the designated line and grade at the outlet end with the groove end or bell end pointing in the direction to be followed by the pipe laying.

Abutting ends of the sections of pipe to be jointed shall then be cleaned and wetted, after which joining mortar shall be firmly placed into the lower half of the groove end of the previously laid section. Joining mortar shall be firmly placed on the top half of the tongue end of the section to be jointed which shall then be inserted truly and snugly into the groove end of the section previously laid so as to completely fill the joint.

The interior joint shall then be either brushed or pointed and all surplus mortar removed from the pipe. The external space between the ends of the jointed pipe shall be firmly filled from the outside with laying mortar.

When pipe with self-centering joints and without an inside pointing recess is furnished, the inside shoulder of the groove end of each section shall first be lightly plastered or buttered with joining mortar after which the pipe ends shall be firmly fitted together in such a way that the tongue end of each section fits snugly into the groove end of the preceding section in order to center the joint and form a true flow line. The inside joints shall be troweled or brushed smooth and excess mortar removed from the pipe. The outside joint recesses shall then be filled with mortar, after which backfilling shall be performed as specified.

When pipe is furnished with self-centering joints with both inside and outside pointing recesses, the pipe shall be firmly fitted together in such a way that the tongue end of each section fits snugly into the groove end of each preceding section in order to center the joint and to form a true flow line, after which the inside joint recess shall be firmly filled with pointing mortar and then troweled or brushed smooth and excess mortar removed from the pipe, after which backfilling shall be performed as specified.

Backfill of the pipe trench may be completed while the joint mortar is still plastic. Should the joint mortar become set before the backfill is placed,

backfilling of the trench shall not be commenced within sixteen (16) hours of jointing the pipe sections. When the pipe is not backfilled while the mortar is plastic, the mortar shall be cured in accordance with subsection 501.03.09, "Curing."

Free water shall not be allowed to come in contact with the pipeline until the mortar in the joints has set at least twenty-four (24) hours.

Concrete pipe with elliptical reinforcing shall be suitably marked to clearly indicate the top and bottom of the pipe.

Prior to placing backfill material, all handling holes in concrete culverts shall be completely filled with grout.

603.03.04 Rubber Gasketed Joints. Reinforced concrete culvert pipe, connected by flexible, watertight, rubber or plastic gasketed joints, may be used in lieu of other types of joints. Rubber or plastic gaskets shall conform to the requirements of subsection 707.03.02 of these specifications.

Reinforced concrete pipe used in sanitary sewer lines shall be connected with flexible, watertight, rubber or plastic gasketed joints and the use of other type joints is prohibited. Rubber or plastic gaskets shall conform to the requirements of subsection 707.03.02 of these specifications.

All rubber gaskets shall be stored in as cool a place as practicable, preferably at seventy (70) degrees Fahrenheit or less, and in no case shall the rubber gaskets be exposed to the direct rays of the sun for more than seventy-two (72) hours.

Rubber gaskets of the type requiring lubrication shall be lubricated with the lubricant recommended and supplied by the manufacturer of the pipe.

After the pipe has been laid, the outer and inner annular space between pipe sections shall be completely filled with cement mortar, except that no mortar shall be required if the space is three-sixteenths ($^3/_{16}$) inch or less in width. Where reinforced concrete collars or bells with rubber gaskets are used at the pipe joints, mortar will not be required in the outer annular space. Where pipes are used with exposed metal surfaces at the joint, both the inner and outer annular joint spaces between pipe sections must be completely filled with cement mortar, except that pipes less than twenty-four (24) inches in diameter may be jointed inside by brushing smooth and removing all surplus mortar. The rubber gasket shall be the sole element depended upon to make the joint watertight for the purposes intended.

603.03.05 Siphons and Pressure Pipe. Reinforced concrete pipe used for siphons or pressure pipe shall be laid in accordance with the above provisions, be connected by flexible, watertight rubber gasketed joint, and prior to backfilling, be subject to the following hydrostatic test:

The pipeline shall be filled with water at a hydrostatic head of ten (10) feet above the highest point of the pipeline. The pressure head shall be maintained for a period of not less than twenty-four (24) hours and any visible leak or other defects which develop under test shall be corrected by the Contractor at his expense. Sweating that does not develop into a flow or drip will not be considered as leakage. The test shall be repeated until all leaks or other defects are eliminated.

METHOD OF MEASUREMENT

603.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement," and in addition thereto, the following requirements shall apply.

The quantity of reinforced concrete pipe to be measured for payment will be the actual number of linear feet of pipe, of the class and size specified complete in place exclusive of precast end sections. Precast end sections will be measured for payment on an each basis.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

603.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of reinforced concrete pipe measured as specified in subsection 603.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for reinforced concrete pipe of the class and size specified, which payment shall include mortar and joints. End sections will be paid for at the contract unit price bid per each for the kind and sizes specified complete and in place, which payment shall include structure excavation and backfill for precast end sections.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Reinforced Concrete Pipe (class)	Linear Foot
(size) Oval Reinforced Conc. Pipe (class)	Linear Foot
(size) Reinforced Conc. Siphon Pipe (class)	Linear Foot
(size) Reinforced Conc. Pipe (class) Jacked	Linear Foot
(size) Precast End Section	Each
(size) Precast Oval End Section	Each

15

SECTION 604

CORRUGATED METAL PIPE AND METAL ARCH PIPE

DESCRIPTION

604.01.01 General. This work shall consist of furnishing and installing corrugated metal pipe, corrugated metal arch pipes, nestable corrugated metal pipe, and slotted corrugated metal pipe, and the relaying of old corrugated metal pipe and pipe arches at locations shown on the plans, or established by the Engineer, and in accordance with the requirements of these specifications.

MATERIALS

604.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 601.02.01 of Section 601, "Pipe Culverts—General," and in addition thereto, the following requirements shall apply.

Material for corrugated metal pipe shall conform to the gage shown on the plans. All gage determinations were based on steel pipe with two and two-thirds (2⅔) by one-half (½) inch corrugations as indicated on the plan sheet entitled, "Allowable Fill Heights for Culverts."

Minimum gages for conduits and coupling bands shall be as indicated for two and two-thirds (2⅔) by one-half (½) inch corrugated steel pipe as shown on the plan.

Three (3) by one (1) inch or five (5) by one (1) inch corrugations for corrugated steel designed for the same or greater fill height, as noted on the plans and in conformance with the fill height tables shown in the plans, may be substituted for the two and two-thirds (2⅔) by one-half (½) inch corrugations.

Two and two-thirds (2⅔) by one-half (½) inch, three (3) by one (1) inch, or six (6) by one (1) inch corrugations for corrugated aluminum pipe designed for the same or greater fill height, as noted in the plans and in conformance with the fill height tables shown in the plans, may be substituted for two and two-thirds (2⅔) by one-half (½) inch corrugated steel pipe.

Aluminum corrugated metal pipe and end sections conforming to the requirements of Section 605 may be furnished in lieu of steel corrugated metal pipe and end sections at the locations shown on the plans. Aluminum corrugated metal pipe shall be fabricated of the gage of material required for the height of fill as set forth on the plans and in conformance with the fill height tables shown on the plans. Aluminum end sections shall be fabricated of the gage of material as set forth in the plans for metal end sections. At each location where corrugated metal pipe is installed, the pipe and all accessories shall be fabricated of the same material.

When metal end sections are required, the following requirements shall pertain:

(a) Metal end sections shall be of the gage shown on the plans.

(b) On all new pipe, the end of the pipe shall be finished with annular corrugations to conform to the metal end section so that no leakage results from the connection.

(c) Where connector sections are used with new pipe, the connector section shall be annular.

(d) When connector sections are used with existing pipe, the connector section may be helical or annular to match the existing pipe.

Metal end sections shall conform to the details and dimensions shown on the plans and, except for shape, shall conform to the requirements of this section for corrugated metal pipe culverts.

Culverts shall be shipped and handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating. Damaged spelter coating in lieu of the requirements of AASHTO Designation M36, may be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating after which the cleaned area shall be painted with two (2) coats of zinc oxide-zinc dust paint conforming to the requirements of Federal Specification MIL–P–15145. The paint shall be properly compounded in a suitable vehicle in the ratio of one (1) part zinc oxide to four (4) parts zinc dust by weight.

CONSTRUCTION

604.03.01 General. Construction methods shall conform to the requirements of subsection 601.03.01 through 601.03.06 of Section 601, "Pipe Culverts—General," and in addition thereto, shall meet the following requirements.

604.03.02 Laying Culvert Pipe. All pipes shall be laid upgrade, unless otherwise permitted by the Engineer.

Corrugated metal pipe shall be so laid that flow is over the lap of the sheets. Field joints shall be made by butting the ends of pipe together and sections joined with a band bolted firmly in place. When so indicated on the plans, pipes shall be elongated vertically five (5) percent before placement of fill. Elongation of the vertical diameter may be accomplished by jacking in the field or by prefabrication. The method of jacking shall be subject to the approval of the Engineer. A tolerance of twenty-five (25) percent above or below the specified amount will be allowed. Where preformed elliptical pipe (elongated by prefabrication) is used, further distortion is not required. Strutting of preformed elliptical pipe will not be required.

Strutting shall be carried uniformly from end to end of pipes where headwalls are not used. When headwalls are used, the amount of jacking and the length of struts may be reduced gradually under the side slopes of the embankment so that the ends of the pipe at the headwalls are circular. The struts shall be left in place until the embankment is complete and compacted, unless otherwise directed by the Engineer.

All pipes shall be laid true to the designated line, grade, and camber. They shall be fitted and matched so that when laid in the work they will form a smooth and uniform invert.

All possible care shall be used in fitting sections of pipes together so that the joint openings will not be unnecessarily large.

604.03.03 Siphons. Corrugated metal pipe for use as siphons shall be close riveted and soldered and so fabricated as to require a minimum number

of field connections. All rivets on circumferential seams shall be spaced at approximately two and one-half (2½) inch centers with a maximum spacing of three (3) inches. The circumferential and longitudinal seams on the outside of the pipe where the edges of the sheets lap shall be soldered in workmanlike manner, solder being sweated into the joints by means of a torch properly regulated for the purpose. Soldering irons shall not be used on factory seams.

Except as provided hereinbefore, siphons shall conform to the requirements for corrugated metal pipe culverts of this section.

Field joints for close riveted and soldered corrugated metal pipe shall be approved watertight couplings consisting of a corrugated collar drawn tight by means of threaded rods and silo-type lugs. To permit the band to fit snugly into the corrugated ends of the pipe, rivets in the longitudinal seam shall be omitted and the seams adequately soldered.

Before placing the band, the ends of the pipe and the bands shall be cleaned and an amount of plastic bituminous impregnated fibre sufficient to make a rope-like section approximately three-fourths (¾) inch in diameter shall be carefully and evenly compressed into the last two (2) valleys of the corrugation at the ends of the pipe. After placing the connecting band the entire circumference and assembly shall be hammered with a rubber or wooden mallet during the tightening of the bolts and lugs. Other approved types of watertight pipe and joints may be used.

The Contractor, at his expense prior to backfilling, shall completely fill the siphon with water and repair any leaks developing therein.

604.03.04 Relay Culvert Pipes. Corrugated metal culvert pipe, previously removed under the provisions of subsection 202.03.05, "Salvage," and designated for relaying, shall be cleaned and relayed at points called for on the plans or ordered by the Engineer.

The pipe shall be thoroughly cleaned to remove all foreign matter.

604.03.05 Slotted Drains. Slotted corrugated metal pipe drains shall be placed flush with the new or existing pavement surface as indicated on the plans. When a new plantmix bituminous open-graded wearing course is to be placed under the terms of the contract, the slotted drain shall be installed flush with the top of the finished dense graded bituminous surface prior to placing the final open-graded wearing course.

The new or existing pavement shall be saw cut or cut by other approved means that will leave a clean, true vertical edge. The slotted drain shall be backfilled with concrete as indicated on the plans and the concrete shall be placed neat (without forming) against the walls of the excavation.

The Contractor may, at his option, substitute Class D for Class A concrete or Class DA for Class AA concrete for backfill.

METHOD OF MEASUREMENT

604.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement," and in addition thereto, the following requirements shall apply.

The quantity of corrugated metal end sections for culvert pipe or pipe arch

measured for payment will be the number of units of each size of each class complete and in place.

Slotted corrugated metal pipe drain shall be measured for payment on a linear foot basis.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

604.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of corrugated metal pipe, measured as specified in subsection 604.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified. End sections will be paid for at the contract unit price bid per each for the kind and size specified, which payment shall include structure excavation and backfill for fabricated end sections.

Where the Contractor elects to furnish aluminum corrugated metal pipe and end sections in lieu of steel corrugated metal pipe and end sections, such aluminum corrugated metal pipe and end sections shall be measured as corrugated metal pipe and end sections.

Toe plates and/or anchor blocks, used as designated in the plans for metal end sections, will not be paid for directly but shall be considered as included in the unit price paid for "Corrugated Metal End Section" or "Corrugated Metal Arch End Section."

When culvert pipe is designated to be relayed, hauling of the pipe, from the site of removal or from the place where stored to the point or points at which they are to be reinstalled, shall be considered subsidiary to the pipe item and no further compensation will be allowed therefor.

The accepted quantities of slotted corrugated metal pipe drain, measured as specified in subsection 604.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the sizes specified, which price shall be considered full compensation for cutting and removing the pavement, structure excavation, concrete backfill, removal and disposal of excess material, and all labor, tools, equipment, and supplies necessary to install the drains complete in place in the accepted work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Corrugated Metal Pipe (gage)	Linear Foot
(size) Corrugated Metal Pipe (gage) Jacked	Linear Foot
(size) Relay Culvert Pipe (type)	Linear Foot
(size) Corr. Metal Arch Pipe (gage)	Linear Foot
(size) Corr. Metal Syphon Pipe (gage)	Linear Foot
(size) Corr. Metal Nestable Pipe (gage)	Linear Foot
(size) Corr. Metal End Section (type)	Each
(size) Corr. Metal Arch End Section (type)	Each
(size) Slotted Corr. Metal Pipe Drain (gage)	Linear Foot

SECTION 605

ALUMINUM CORRUGATED METAL PIPE AND ALUMINUM ARCH CULVERTS

DESCRIPTION

605.01.01 General. This work shall consist of furnishing and installing corrugated aluminum culvert pipe and pipe arches at the location shown on the plans, or established by the Engineer, and in accordance with the requirements of these specifications.

MATERIALS

605.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 601.02.01 of Section 601, "Pipe Culverts—General."

CONSTRUCTION

605.03.01 General. The construction requirements shall be as prescribed in subsections 604.03.01 through 604.03.04 of Section 604, "Corrugated Metal Pipe and Metal Arch Pipe."

Aluminum corrugated metal pipe gages shall conform to the fill heights and fill height tables shown on the plans.

METHOD OF MEASUREMENT

605.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement."

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

605.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of corrugated aluminum pipe and aluminum arch pipe will be paid for at the contract price bid per linear foot for the types and sizes specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Corrugated Aluminum Pipe	Linear Foot
(size) Corrugated Aluminum Arch Pipe	Linear Foot

SECTION 606

STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

DESCRIPTION

606.01.01 General. This work shall consist of furnishing and installing structural plate pipe and pipe arch culverts conforming to the requirements of these specifications, and of the sizes and dimensions required in the plans, and installing such structures at locations designated in the plans or established by the Engineer, and in conformity with the lines and grades established by the Engineer. The work shall also include the reinstallation of salvaged structural plate pipe and pipe arch culverts.

Plates for a pipe arch shall form a cross section made up of four (4) circular arcs tangent to each other at their junctions and symmetrical about the vertical axis. The top shall be an arc of not more than one hundred eighty (180) degrees nor less than one hundred fifty-five (155) degrees. The bottom shall be an arc of not more than fifty (50) degrees nor less than ten (10) degrees. The top shall be joined at each end to the bottom by an arc having a radius between sixteen (16) and twenty-one (21) inches and of not more than eighty-seven and one-half (87½) degrees nor less than seventy-five (75) degrees.

MATERIALS

606.02.01 General. Materials shall meet the requirements specified in subsection 709.03.08, "Steel Structural Plate Pipe and Pipe Arches," or subsection 709.03.09, "Aluminum Structural Plate Pipe and Pipe Arches," except that at locations where an existing structural plate pipe is to be extended or otherwise modified, the plates and all accessories shall be fabricated of the same material.

If called for in the bid schedule, plates for pipes and pipe arches shall be bituminous coated in accordance with AASHTO Designation M190, Type A, B, or C.

When bituminous coating is applied to plates for structural steel plate pipe, arches, and pipe arches, each plate shall have the thickness painted on the inner surface so that the plate thickness can be readily identified.

The portion of all nuts and bolts, used for assembly of bituminous coated structural steel plate pipes, arches, and pipe arches, projecting outside the pipe shall be bituminous coated after installation. The portion of the nuts and bolts projecting inside the pipe need not be bituminous coated.

Damaged bituminous coating shall be repaired by the Contractor by applying bituminous material conforming to the provisions of AASHTO Designation M190 or other approved material.

The bottom plates of structural plate pipes and arches shall be one (1) gage heavier than the gage specified in the bid schedule, which will apply to top and side plates. When gage one (1) is specified, the bottom plates shall also be gage one (1).

Plates shall be shipped and handled in such a manner as to prevent bruising,

scaling, or breaking of the spelter coating. Damaged spelter coating in lieu of the requirements of AASHTO Designation M36, may be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating after which the cleaned area shall be painted with two (2) coats of zinc oxide-zinc dust paint conforming to the requirements of Federal Specification MIL–P–15145. The paint shall be properly compounded in a suitable vehicle in the ratio of one (1) part zinc oxide to four (4) parts zinc dust by weight.

Planned lengths and sizes are approximate. The Contractor shall not order and deliver the plates until a list of sizes and lengths is furnished him by the Engineer.

CONSTRUCTION

606.03.01 Plate Description. Plates shall consist of structural units of galvanized corrugated metal. Single plates shall be furnished in standard sizes to permit structure length increments of two (2) feet. (Plates have approximately a two (2) inch lip beyond each end crest, which results in the actual length of a given structure being approximately four (4) inches longer than the nominal length, except when skewed or beveled.)

The plates at longitudinal and circumferential seams shall be connected by bolts. Joints shall be staggered so that not more than three (3) plates come together at any one (1) point. Each plate shall be curved to one (1) or more circular arcs.

606.03.02 Fabrication. Plates shall be formed to provide lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross sectional dimensions of the finished structure will be as specified.

Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows two (2) inches apart, with one (1) row in the valley and one (1) in the crest of the corrugations. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than twelve (12) inches. The minimum distance from center of hole to edge of the plate shall be not less than one and three-fourths ($1\frac{3}{4}$) times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than one-eighth ($\frac{1}{8}$) inch.

Burnt edges shall be free from oxide and burrs and shall present a workmanlike finish. Damaged spelter on the surface of the plates and the edges of cuts shall be repaired as set forth in subsection 606.02.01, "General," within twenty-four (24) hours after the cuts are made. Each cut plate shall be legibly identified to designate its proper position in the finished structure.

606.03.03 Field Inspection. The Engineer shall be furnished with an itemized statement of the number and length of the plates in each shipment by the manufacturer. Each plate included in a shipment shall conform to the

requirements of these specifications. If twenty-five (25) percent or more of the plates in any shipment fail to conform to the requirements, the entire shipment may be rejected.

606.03.04 Earthwork. Excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation," and Section 207, "Backfill."

The pipe shall be laid in a trench excavated to the lines and grades established by the Engineer. The bottom of the trench shall be graded and prepared to provide full contact with the pipe throughout its entire length.

Where pipes are to be installed in new embankments on a steep slope or in a difficult location, the height of new embankments may be varied when permitted by the Engineer before installing pipes.

When headwalls are not required and granular materials are used for backfilling, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure in well tamped clay as directed by the Engineer.

When the pipe is laid in rock, hard clay, shale, or other hard material, a space below the pipe shall be excavated and replaced with a bed of compacted sand or compacted earth fill. In no place shall the pipe be laid directly on the rock, hard clay, shale, or other hard material.

When sand or compacted fill is used, the depth of the sand or compacted fill below the pipe shall not be less than one-third (1/3) the inside diameter of the pipe with a minimum of four (4) inches and a maximum of twelve (12) inches with the exception that an extra one-half (1/2) inch shall be added for every foot the trench exceeds sixteen (16) feet in depth. This bed shall extend at the sides of the pipe at least a distance of one-fourth (1/4) the outside diameter of the pipe.

606.03.05 Assembling. The structural plate structures shall be assembled in accordance with the manufacturer's assembly instructions. The unsupported edges of all plates shall be held in position by temporary props. Each row of side plates shall extend far enough to support the plate above until the first complete ring has been assembled. A sufficient number of bolts shall be progressively installed to hold the plates in position. Bolts shall not be tightened until tightening will not interfere with the adjustment and matching of additional plates and sections. Special care shall be exercised in the use of drift pins or pry bars to prevent chipping or injury to the galvanized or other protective coating, and such injury shall be repaired as set forth in subsection 606.02.01, "General," at the Contractor's expense. After all plates are in place, the bolts shall be progressively and uniformly tightened from one (1) end of the structure, and the tightening operation repeated to be sure that all bolts are tight. Bolts shall be tightened to a minimum of (a) one hundred (100) foot-pounds of torque for plates of seven (7) gage and lighter, and (b) one hundred fifty (150) foot-pounds of torque for plates of five (5) gage and heavier, and shall be rechecked and retightened as necessary just prior to backfilling.

The elliptical-shaped pipes shall be installed with their long diameter vertical, and pipe arches shall be installed with their span width horizontal.

606.03.06 Strutting. When specified, structural plate pipes, which are not fabricated out of round before erection, shall be timber strutted vertically three (3) percent out of round before placement of the embankment.

The pipe shall be deformed to the required degree by means of suitable jacks. The method of jacking shall meet with the approval of the Engineer. A tolerance of twenty-five (25) percent above or below the specified elongation will be permitted.

Strutting shall be carried uniformly from end to end of the pipe. The struts shall be left in place until the embankment is complete and compacted, unless otherwise ordered by the Engineer.

In lieu of strutting structural plate pipe, the Contractor may furnish structural plate pipe with the vertical axis fabricated out of round five (5) percent of the nominal diameter from end to end of the pipe. A tolerance of twenty-five (25) percent above or below the specified elongation will be permitted. The elongation shall be made by approved shop methods, and any coating damaged or destroyed shall be repaired or replaced satisfactorily.

606.03.07 Workmanship. It is the essence of these specifications that, in addition to compliance with the details of construction, the completed pipe shall show careful, finished workmanship in all particulars. Structural plates on which the spelter coating has been bruised or broken or which shows defective workmanship, shall be rejected, except as herein otherwise specified. The requirement applies not only to the individual plates, but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship and the presence of any or all of them in any individual culvert plate, or in general in any shipment, shall constitute sufficient cause for rejection:

(a) Uneven laps.

(b) Variation from a straight centerline.

(c) Ragged edges.

(d) Loose, unevenly lined, or spaced bolts.

(e) Bruised, scaled, or broken spelter coating. (See subsection 606.02.01 for exception.)

(f) Dents or bends in the metal itself.

606.03.08 Headwalls. Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with structural plate pipe. Where such headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the Engineer. Headwalls to be constructed to conform to the applicable requirements of Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures."

606.03.09 Extending Existing Structural Plate Pipe and Pipe Arch Culverts. In case the plans provide for the extension of any old or existing structural plate pipe or pipe arch culverts, the connection of the old and new sections shall be made by punching any necessary bolt holes, furnishing bolts, nuts, and washers, changing location of individual plates on pipe arches, and any other work required in the completion of the connection in a workmanlike

manner. In all cases where an existing headwall is in place, the concrete shall be completely removed in accordance with the provisions of Section 202, "Removal of Structures and Obstructions."

METHOD OF MEASUREMENT

606.04.01 Measurement. The materials to be paid for under these specifications will be listed in the contract items by the various sizes, types, and gages necessary for identification.

The quantity of structural plate pipe or pipe arches measured for payment will be the number of linear feet complete and in place. The number of linear feet shall be the average of the top and bottom centerline lengths for structural plate pipe and pipe arches.

Structure excavation and structure backfill, Portland cement concrete, and reinforcement required for headwalls, structures, and other items required to complete the work will be measured and paid for under their respective sections of these specifications.

Coating the structural plate pipe with asphalt water-proofing material, if required, will not be measured for payment but the cost thereof shall be considered included in the contract unit price bid for other items of work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

606.05.01 Payment. The accepted quantities of structural plate pipe and pipe arches measured as specified in subsection 606.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

Full compensation for furnishing structural plate pipe and pipe arches with end finish, including distortion, if required, will be considered as included in the price paid per linear foot for the plates and pipe involved and no additional compensation will be allowed therefor.

Provisions for handling of whatever water may be encountered at the site shall be an obligation of the Contractor, and payment therefor shall be considered as subsidiary to the items involved and no further compensation will be allowed therefor.

The gage of metal in the bottom plates of pipes and pipe arches is to be of a gage heavier than that specified in the bid schedule as set forth in subsection 606.02.01, "General," unless otherwise specified. No separate or additional compensation will be made by reason of supplying the heavier gage but compensation therefor shall be considered an integral part of the contract price paid for the gage specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Structural Plate Pipe (type) (gage)	Linear Foot
(size) Structural Plate Pipe Arch (type) (gage)	Linear Foot

SECTION 607

UNDERDRAINS

DESCRIPTION

607.01.01 General. This work shall consist of constructing underdrains using pipe and drain backfill in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

607.02.01 General. Material shall meet the requirements specified in the following subsections:

Corrugated Metal Pipe for Underdrains	Subsection 709.03.05
Bituminous Coated Corrugated Metal Pipe for Underdrains	Subsection 709.03.06
Perforated Concrete Pipe	Subsection 708.03.03
Clay Pipe	Subsection 708.03.04
Corrugated Aluminum Pipe for Underdrains	Subsection 709.03.07
Drain Backfill	Subsection 704.03.01
Corrugated Polyethylene Pipe	Subsection 708.03.07

Unless otherwise provided in the contract documents, the Contractor shall have the option of providing pipe for underdrains consisting of steel corrugated metal, aluminum corrugated metal, concrete, clay, or corrugated polyethylene pipe

Each separate underdrain installation shall be assembled from one (1) material only. Metal pipe shall be sixteen (16) gage unless otherwise noted on the plans.

Two (2) weeks in advance of the preconstruction conference, the Contractor shall submit to the Engineer, in writing, the type of underdrain pipe he will furnish. Once a choice has been made, the Contractor shall not be allowed to change the type of material chosen.

When the location of manufacturing plants allows, the plants will be inspected periodically for compliance with specified manufacturing methods, and materials samples will be obtained for laboratory testing for compliance with materials quality requirements. This can be the basis for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials into the work.

The lengths shown on the plans are approximate. The Contractor shall not order and deliver the pipe until a correct list of sizes and lengths is furnished him by the Engineer.

Pipe shall be shipped and handled in such a manner as to prevent bruising, sealing, or breaking. Corrugated metal pipe with damaged spelter coating may be repaired in accordance with subsection 604.02.01 of Section 604, "Corrugated Metal Pipe and Metal Arch Pipe." Concrete or clay pipe which is

cracked, checked, spalled, or damaged shall not be laid. Pipes which show defects due to handling shall be rejected at the site of the installation regardless of prior acceptance.

CONSTRUCTION

607.03.01 Earthwork. Excavation and drain backfill shall conform to the requirements of Sections 206, "Structure Excavation," and 209, "Drain Backfill," with the following modifications:

(a) Trenches shall be excavated to the dimensions and grade required by the plans or as directed. A minimum three (3) inch bedding layer of drain backfill material shall be placed in the bottom of the trench for its full width and length.

(b) The space below the pipe shall be filled with the required drain backfill throughout its entire length, and brought to a uniform grade. All material excavated from trenches, not required for backfilling, nor usable in the roadway, shall be removed and disposed of by the Contractor.

(c) If an item for grouting drain backfill is shown in the proposal, drain backfill shall be covered with a thick grout not less than one (1) inch in thickness. The grout shall be composed of one (1) part Portland cement and five (5) parts sand. This grout shall be thoroughly tamped to provide an impervious layer over the entire surface of the drain backfill.

607.03.02 Laying Pipes. Bell and spigot tile shall be laid upgrade with the bell end upgrade and the spigot end not quite fully entered in the adjacent bell. Pipe shall be laid true to line and grade with a uniform bearing under the full length of the barrel. The pipe joints shall then be covered with two (2) ply tar paper strips not less than six (6) inches in width and of sufficient length to permit the ends being turned outward and laid flat on the bottom course of drain backfill on either side of the pipe for a distance of three (3) inches.

When the type of pipe chosen for use does not permit perforations around the full circumference, perforated pipe shall be laid with the perforations at the bottom of the pipe. The pipe shall be firmly bedded throughout its length.

Metal pipe sections shall be joined with band couplers; concrete and clay pipe sections shall be joined as specified in the appropriate section of these specifications; and corrugated polyethylene pipe sections shall be joined by snap couplers, split couplers, or spin-on couplers as recommended by the manufacturer.

607.03.03 Underdrain Outlets. Trenches for underdrain outlets shall be excavated to the width and depth shown on the plans. Pipe shall be laid in the trench with all ends firmly joined by the applicable methods and means. After inspection and approval of the pipe installation, the trench shall be backfilled with structure backfill material in layers and compacted as provided in Section 209, "Drain Backfill."

METHOD OF MEASUREMENT

607.04.01 Measurement. The materials to be measured for payment under these specifications will be listed in the contract items by size, class, type gage, or whatever information is necessary for identification.

Quantities shown on the plans are based on corrugated metal pipe. There shall be no adjustment of said quantities due to the Contractor's choice of materials.

The quantity of underdrain pipe measured for payment will be the actual number of linear feet of pipe complete and in place. Underdrain pipe bends, wyes, tees, and other branches will be measured along centerlines to the point of intersection.

The quantity of grouted drain backfill measured for payment will be the actual number of linear feet of drain grouted, measured along the longitudinal axis of the drain, in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

607.05.01 Payment. The accepted quantities of underdrain pipe measured as specified in subsection 607.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

The accepted quantity of grouted drain backfill measured as provided in subsection 607.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for grouting drain backfill.

Structure excavation and drain backfill will be measured and paid for as separate items as provided in Sections 206, "Structure Excavation," and 209, "Drain Backfill," except that structure excavation and drain backfill will be paid for in accordance with the quantity required for the installation of corrugated metal pipe regardless of the type of pipe installed.

Provisions for handling of whatever water may be encountered, at the site, shall be an obligation of the Contractor and payment therefor shall be considered as subsidiary to the items involved and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Perforated Pipe	Linear Foot
(size) Nonperforated Pipe	Linear Foot
Grouting Drain Backfill (width)	Linear Foot

SECTION 608

DOWNDRAINS

DESCRIPTION

608.01.01 General. This work shall consist of furnishing and installing embankment protectors, anchor assemblies, metal end sections, and light riprap to collect and carry surface drainage down the roadway slopes and to disperse water at the outlet of the downdrain.

MATERIALS

608.02.01 General. The materials used shall be those prescribed or used for the several items which constitute the finished work and shall conform to the requirements in the following sections and subsections:

Corrugated Metal Pipe for Downdrains	Subsection 709.03.04
Corrugated Aluminum Pipe	Subsection 709.03.03
Corrugated Polyethylene Pipe	Subsection 708.03.07
Light Riprap	Section 610
Concrete	Section 501
Reinforcing Steel	Section 505
Frames for Grates	Section 609

At the Contractor's option, downdrain pipe may be steel corrugated metal, aluminum corrugated metal, or corrugated polyethylene pipe, unless otherwise noted on the plans.

Metal pipe for downdrains shall be sixteen (16) gage unless otherwise noted on the plans.

Except as hereinafter provided, each separate downdrain installation shall be assembled from one (1) material only. Ferrous metal and aluminum shall not be used in the same installation except that the anchor assemblies as shown on the plans may be used with an aluminum installation provided the anchor assemblies are electrically insulated. Polyethylene corrugated pipe shall be connected to metal end sections at the outlet in accordance with the manufacturer's recommendations.

Corrugated metal parts with damaged spelter coating shall be repaired in accordance with subsection 604.02.01, "General."

Metal end sections shall conform to the requirements of Section 604, "Corrugated Metal Pipe and Metal Arch Pipe," or Section 605, "Aluminum Corrugated Metal Pipe and Aluminum Arch Culverts," depending upon the material chosen for use.

CONSTRUCTION

608.03.01 General. The embankment protector outlet pipe shall be connected to a downdrain pipe of the dimensions shown on the plans by means of a band coupler or in the event polyethylene pipe is chosen for use, snap couplers, split couplers, or spin-on couplers as recommended by the manufacturer.

Embankment protectors shall be installed at the outside edge of the embankment gutters or in shoulder dikes to carry drainage from the roadbed down the embankment slopes to protect the slopes and shoulders from erosion. The entrance device shall be so installed as to prevent water from percolating around the structure and care shall be taken to prevent the structure from being undermined. The seal between the structure and the surrounding earth shall be made watertight. The embankment protectors shall be placed in such a manner that the lower edge of the opening will be from three (3) inches to six (6) inches below the bottom of the gutter flow lines.

Regardless of the type of downdrain pipe chosen for use, anchor assemblies shall be installed as indicated on the plans.

An anchor assembly shall consist of pipe stakes, rods, and hardware for fastening downdrain pipe as shown on the plans.

METHOD OF MEASUREMENT

608.04.01 Measurement. The materials to be measured for payment under these specifications will be listed in the contract items by size, type, etc., or whatever information is necessary for identification.

The quantity of embankment protectors, metal end sections, and anchor assemblies will be measured as units complete and in place.

The quantity of corrugated pipe downdrains measured for payment will be the number of linear feet complete and in place.

Embankment protectors shall be measured as units complete in place as shown on the plans and as approved by the Engineer, except corrugated pipe downdrain shall be measured for payment including the length of pipe cast into the embankment protector.

The quantity of elbows, wyes, tees, and other branches measured for payment will be the number of linear feet for the size and type of pipe involved, complete and in place. Wyes, elbows, tees, and other branches will be measured along centerlines to the point of intersection.

Metal end sections for downdrains shall be measured for payment on an each basis complete in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

608.05.01 Payment. The accepted quantities of embankment protectors, anchor assemblies, and metal end sections, measured as specified in subsection 608.04.01, "Measurement," will be paid for at the contract unit price bid per each for the types and sizes specified.

The accepted quantities of downdrain pipe, measured as specified in subsection 608.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for downdrain pipe for the sizes specified.

Payment for structure excavation, backfill, and light riprap will be considered subsidiary to the items of embankment protectors and downdrain pipe and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Embankment Protector (type)	Each
Anchor Assembly	Each
(size) Downdrain Pipe	Linear Foot
(size) Metal End Section	Each

SECTION 609

CATCH BASINS, MANHOLES, AND INLETS

DESCRIPTION

609.01.01 General. This work shall consist of constructing or reconstructing catch basins, manholes, inlets, and similar structures, consisting of Portland cement concrete with necessary reinforcement, metal frames, grates, and lids, including required excavation and backfilling.

MATERIALS

609.02.01 General. Materials shall conform to the requirements specified in the following sections and subsections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505
Miscellaneous Metals	Section 712
Gray Iron Castings	Subsection 712.03.02

Portland cement concrete shall be Class A or Class AA unless otherwise provided.

Casting shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting strength and value for the service intended. Casting shall be boldly filleted at angles and the arrises shall be sharp and perfect. Casting shall be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface.

Mortar for setting grates shall be mixed in the proportions of one (1) part cement to three (3) parts of fine aggregate.

Pipe crossbars for drop inlets shall be unpainted standard weight black pipe conforming to the requirements of ASTM Designation A53 or A120. Straps shall be unpainted A36 steel.

CONSTRUCTION

609.03.01 General. Catch basins, inlets, and manholes shall be constructed in accordance with all of the requirements of Section 501, "Portland Cement Concrete." Inlet and outlet pipes shall be placed prior to pouring concrete.

Construction of catch basins, manholes, and inlets that require the diversion of public traffic during their construction shall be precast in accordance with the details shown on the plans. Excavations required to accommodate such structures shall not be permitted to begin until the structure has been constructed, cured, and is ready for installation. Once installation has been commenced, work thereon shall be continuous on a working day by working day basis until such time as public traffic is allowed the use of the area as approved by the Engineer.

Grates shall be set in full mortar beds or otherwise secured as shown on the

plans. Grates shall be set accurately to the final elevations so that no subsequent adjustments will be necessary. Concrete covers, when indicated on the plans, shall be constructed in such manner that they will fit snugly and be readily removable. Grates, frames, and castings for all drop inlets and manholes shall not be painted or galvanized.

Pipe or tile placed in masonry for inlet or outlet connections shall extend through the walls and beyond the outside surfaces of the walls a sufficient distance to allow for connections with conduits and the masonry shall be carefully constructed around them so as to prevent leakage around their outer surfaces.

Commercially prefabricated frames and grates of equal or greater capacity and strength may be substituted for the design shown on the plans for drop inlets provided prior approval is obtained in writing from the Engineer.

Frames and grates shall be matchmarked in pairs before delivery to the work and grates shall fit into their frames without rocking.

Where pipe grates are designated for use, substitution of other type grates will not be permitted.

609.03.02 Adjusting Catch Basin, Manhole, and Inlet Covers. Existing catch basin, manhole, inlet covers, valve and meter covers, etc., shall be adjusted where indicated on the plans and as directed by the Engineer. The adjustment shall be accomplished by one (1) of the following methods depending on the type of construction involved.

Method A. This method shall apply when removal of the existing pavement by cold milling is not required. The method shall consist of paving over the existing cover and once all paving is completed, locating and adjusting the cover to the final finished pavement level. Appropriate measures shall be taken to prevent paving materials from entering any openings in the cover.

Method B. This method shall apply when removal of the existing pavement by cold milling is required. The method shall consist of lowering the cover sufficiently to accommodate the required pavement removal depth prior to cold milling. In the event the lowered cover presents a hazard to public safety, the Contractor shall provide protection therefrom in a manner approved by the Engineer. Once pavement removal has been completed, the new pavement shall be completed and the cover shall be located and adjusted to the final pavement level. Appropriate measures shall be taken to prevent existing or new paving materials from entering any openings in the cover.

Method C. This method shall apply to the adjustment of existing covers outside the areas described in Methods A and B of this subsection. Existing covers, including frames, grates, or lids, shall be adjusted to the required elevation by removing such existing covers and adjusting the top of the existing structures by removing or adding concrete, brick masonry, or concrete block masonry, as the case may be, and reinstalling the fixtures firmly in place.

609.03.03 Clean Out. All catch basins, manholes, inlets, and similar structures shall be thoroughly cleaned of any accumulations of silt, debris, or foreign matter of any kind, and shall be clean of such accumulations at the time of final inspection.

609.03.04 Earthwork. Structure excavation and structure backfill shall conform to the requirements of Sections 206, "Structure Excavation," and 207, "Backfill."

METHOD OF MEASUREMENT

609.04.01 Measurement. The quantities of castings and structural steel grates measured for payment will be the number of pounds, complete and in place. The weight of castings shall be computed from the dimensions shown on the approved shop drawings, assuming the cast iron to weigh four hundred fifty (450) pounds per cubic foot, with an allowance of ten (10) percent for fillets and overrun. The weight of structural steel grates shall be computed from the dimensions shown on the approved shop drawings, in accordance with Section 506, "Steel Structures." Certified shop weights will be acceptable in lieu of computed weights.

Adjusting covers for catch basins, manholes, inlets, valves, and meters shall be measured on an each basis complete in place and each method of adjustment (A, B, or C) shall be considered separately.

Precast manholes of the type and dimensions shown on the plans will be measured per each complete and in place.

Pipe crossbars and straps for drop inlets shall be included in the measurement for payment by the contract bid price per pound for structural steel grates.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

609.05.01 Payment. The accepted quantities of grates measured as provided in subsection 609.04.01, "Measurement," will be paid for at the contract unit price bid per pound for types and sizes specified.

The contract unit price bid each for "Adjusting Covers (Method A)," measured as provided above, shall be considered full compensation for all labor, materials, tools, equipment, and incidentals required to locate and adjust the cover to finished grade including any work necessary to finish around the adjusted cover, complete in place in the accepted work.

The contract unit price bid each for "Adjusting Covers (Method B)," measured as provided above, shall be considered full compensation for all labor, materials, tools, equipment, and incidentals required to lower the cover, provide hazard protection, locate and adjust the cover to finished grade including any work necessary to finish around the adjusted cover, complete in place in the accepted work.

The contract unit price bid each for "Adjusting Covers (Method C)," measured as provided above, shall be considered full compensation for all labor, materials, tools, equipment, and incidentals required to adjust the cover to finished grade including any work necessary to finish around the adjusted cover, complete in place in the accepted work.

Portland cement concrete used in new structures of catch basins and inlets will be paid for as specified in Section 502, "Concrete Structures."

Reinforcing steel in catch basins and inlets will be paid for as specified in Section 505, "Reinforcing Steel."

The accepted quantity of precast manholes measured as provided in subsection 609.04.01, "Measurement," will be paid for at the contract unit price bid per each for types and sizes specified. This price shall be full compensation for furnishing all materials including structure excavation and structure backfill, Portland cement concrete, steel, castings, and incidentals necessary to complete the work.

Structure excavation and structure backfill for catch basins and inlets will be paid for as specified in Sections 206, "Structure Excavation," and 207, "Backfill."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Castings	Pound
Structural Steel Grates	Pound
(size) Precast Reinforced Concrete Manhole (type)	Each
Adjusting Covers (Method A)	Each
Adjusting Covers (Method B)	Each
Adjusting Covers (Method C)	Each

SECTION 610

RIPRAP

DESCRIPTION

610.01.01 General. This work shall consist of furnishing and placing riprap (with or without grout) or sacked Portland cement concrete riprap as the case may be. The type(s) of riprap shall be as indicated on the plans and shall conform to the applicable requirements of these specifications.

MATERIALS

610.02.01 General. All materials shall conform to the requirements specified in the following sections and subsections:

Water	Section 722
Stone for Masonry and Riprap	Subsection 706.03.05
Portland Cement	Section 701
Grout and Mortar Sand	Subsection 706.03.04

When so provided, waste concrete slabs may be substituted for the above-designated stone. In such case, the concrete shall be sound and the slabs shall meet the size requirements as specified for stone.

Grout shall be composed of one (1) part by volume of Portland cement and three (3) parts by volume of sand and shall be of such consistency that it will fill voids in the riprap.

The mixed concrete shall contain three hundred seventy-six (376) pounds (four (4) sacks) of Portland cement per cubic yard.

The amount of water added at the time of mixing shall be such as will produce a mixture with a slump of from three (3) inches to five (5) inches when tested in accordance with the method described in Section 501 of these specifications.

Unless otherwise provided in the special provisions, aggregate for use in sacked concrete riprap shall consist of material of a sandy, gravelly nature, clean and free from roots, vegetable matter, and other deleterious substances. When tested on laboratory sieves, material shall conform to the following grading requirements:

Passing a 2-inch sieve	80 to 100 percent
Passing a No. 200 sieve	0 to 4 percent

(a) Size of Riprap—General. The largest dimension of any riprap stone shall be no larger than three (3) times the smallest dimension.

(b) Size of Light Riprap. Individual stones shall have a minimum dimension of not less than three (3) inches. Not more than ten (10) percent of the stones shall weigh more than fifty (50) pounds each and not more than fifty (50) percent of the stones shall weigh less than twenty-five (25) pounds each.

(c) Size of Medium Riprap. Ten (10) percent of the stones shall have a minimum dimension of not less than three (3) inches. The remaining ninety

(90) percent of the stones shall have a minimum dimension larger than six (6) inches.

(d) Size of Heavy Riprap. Size of riprap stone shall be as large as can be conveniently placed in layer thickness specified. In layers two (2) feet or less in thickness, the stones, excepting spalls used to chink interstices, shall weigh not less than fifty (50) pounds, and at least sixty (60) percent of them shall weigh more than one hundred (100) pounds each. In layers more than two (2) feet in thickness at least fifty (50) percent of the mass shall be stones having a volume of two (2) cubic feet or more.

(e) Size of Grouted Riprap. Individual stones shall have a minimum dimension of not less than six (6) inches and a maximum dimension of not more than one and one-half (1½) times the thickness of the riprap section shown on the plans.

CONSTRUCTION

610.03.01 Earthwork. The bed for the riprap shall be properly trimmed and shaped. Excavations for trenches, footings, cutoff walls, etc., shall conform to the requirements of Section 206, "Structure Excavation." Gradation and compaction requirements on structure backfill will not apply.

610.03.02 Light and Medium Riprap. Light and medium riprap may be placed by mechanical means that will produce a well graded, uniform rock blanket in close conformity with the typical section shown on the plans as approved by the Engineer. Interstices between stones shall be chinked with spalls firmly rammed into place.

610.03.03 Heavy Riprap. Heavy riprap may be placed by any mechanical means that will produce a complete job within reasonable tolerances of the typical section shown on the plans. Hand work will be limited to the amount necessary to fill large voids or to correct segregated areas.

610.03.04 Grouted Riprap. Stone shall be placed by hand. It shall be laid with close, broken joints and shall be firmly bedded into the slope and against adjoining stones. The stones shall be laid perpendicular to the slope with the ends in contact. The finished face shall present an even, tight surface. The space between the stones shall then be filled with grout. Sufficient grout shall be used to completely fill all voids, except that the face surface of the stone shall be left exposed.

After grouting the surface shall be cured as specified in Section 502, "Concrete Structures," for a period of at least three (3) days.

610.03.05 Sacked Concrete Riprap. Sacks for concrete riprap shall be made of at least ten (10) ounce burlap and shall be approximately nineteen and one-half (19½) inches by thirty-six (36) inches measured inside the seams when the sack is laid flat. The capacity of each sack shall be approximately one and twenty-five one-hundredths (1.25) cubic feet. Sound reclaimed sacks may be used. The sacks shall be filled with concrete, loosely placed so as to leave room for folding at the top, the fold to be just

enough to retain the concrete at the time of placing. Not more than one (1) cubic foot of concrete shall be placed in each sack. Immediately after being filled with concrete, the sacks shall be placed and lightly trampled to cause them to conform with the earth face and with adjacent sacks in place.

The slopes on which the sacked concrete riprap is to be placed shall be finished true to line and grade. The first course shall consist of a double row of stretchers laid in a neatly trimmed trench, and the second course shall consist of a single row of headers. The third and remaining course shall consist of stretchers and shall be placed in such a manner that joints in succeeding courses are staggered. All dirt and debris shall be removed from the top of the sacks before the next course is laid thereon. Stretchers shall be placed so that the folded ends will not be adjacent. Headers shall be placed with the folds toward the earth face. Not more than four (4) vertical courses of sacks shall be placed in any tier until initial set has taken place in the first course of any such tier.

When, in the opinion of the Engineer, there will not be proper bearing or bond for the concrete due to delays in placing succeeding layers of sacks or due to the work having been hampered by storms or mud or for any cause, a small trench shall be excavated back of the row of sacks already in place, which trench shall be filled with fresh concrete before the next layer of sacks is laid.

Sacked concrete riprap shall be cured by covering with a blanket of wet earth or by sprinkling with a fine spray of water every two (2) hours during the daytime for a period of four (4) days.

METHOD OF MEASUREMENT

610.04.01 Measurement. The quantity of light riprap, medium riprap, heavy riprap, and grouted riprap measured for payment will be the number of cubic yards complete and in place, and each type of riprap will be considered separately.

The quantity of sacked concrete riprap to be measured for payment will be the number of cubic yards at the mixer. Only work placed within the dimensions shown on the plans or ordered by the Engineer will be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

610.05.01 Payment. The accepted quantities of light riprap, medium riprap, heavy riprap, grouted riprap, and sacked concrete riprap measured as provided in subsection 610.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard for the type specified.

Structure excavation for trenches, footings, cutoff walls, etc., will be paid for in accordance with Section 206, "Structure Excavation." Backfill will be considered as included in the price paid for structure excavation and no separate payment will be made therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Light Riprap	Cubic Yard
Medium Riprap	Cubic Yard
Heavy Riprap	Cubic Yard
Grouted Riprap	Cubic Yard
Sacked Riprap	Cubic Yard

SECTION 611

CONCRETE SLOPE PAVING

DESCRIPTION

611.01.01 General. This work shall consist of constructing concrete slope paving, including aprons and cutoff walls in connection therewith, to the lines and grades established by the Engineer in accordance with the design shown on the plans.

MATERIALS

611.02.01 General. Materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505

Concrete slope paving, aprons, and concrete cutoff walls shall be Class A or Class AA Portland cement concrete; however, the Contractor may at his option substitute Class DA for Class AA concrete or Class D for Class A concrete.

Mesh reinforcing for ditch lining and slope paving reinforcement shall be of the sizes shown on the plans, fabricated of cold drawn steel wire and need not be galvanized. Mesh reinforcing shall conform to the requirements of Section 505, "Reinforcing Steel."

Header boards consisting of two (2) inch by four (4) inch redwood lumber furnished and placed in concrete slope paving shall be as shown on the plans. Lumber used in the construction of header boards shall be commercial grade heart redwood, S4S.

Nails used in construction of header boards shall be commercial quality galvanized nails.

CONSTRUCTION

611.03.01 Earthwork. The subgrade for paved ditches and slope paving shall be formed by excavating to the required depth below the prepared finish surface grade in accordance with dimensions and design indicated on the plans or as directed by the Engineer.

The subgrade shall be thoroughly compacted to a relative density of at least ninety-five (95) percent as determined by Test Methods No. Nev. T101, T102, or T103. Test method to be determined by the Engineer. Any soft, spongy, or other unsuitable material shall be removed to such depth as directed and backfilled with suitable material and thoroughly compacted as specified in this subsection. Water shall be sprinkled on the subgrade during compaction and the subgrade shall be sufficiently moist prior to placing concrete to prevent absorption.

Excavation for trenches, footings, cutoff walls, etc., shall conform to the requirements of Section 206, "Structure Excavation." Gradation and compaction requirements on structure backfill will not apply.

611.03.02 General. Concrete, after spreading, shall be tamped until it is thoroughly compact and mortar flushes to the surface. If the slope is too steep to permit the use of concrete sufficiently wet to flush with tamping, the concrete may be tamped until consolidated and a mortar surface one-fourth (1/4) inch thick troweled on immediately. The mortar shall consist of one (1) part Portland cement and three (3) parts of clean, sharp sand. The mortar surface shall be considered as a part of the concrete and no additional allowance will be made therefor.

After striking off to grade, the concrete shall be hand floated with wooden floats not less than four (4) inches in width and not less than thirty (30) inches in length. Care shall be taken to prevent rotary marks of the hand floats. The entire surface shall be broomed with a fine texture hair push broom to produce a uniform surface and eliminate float marks. Brooming shall be done when the surface is sufficiently set to prevent deep scarring and shall be accomplished by drawing the broom down the slope leaving the marks parallel to the edges of the panel. Joints shall be edged with a one-fourth (1/4) inch radius edger prior to the brooming.

All concrete or mortar surface for slope paving, except that used in ditch lining, shall have an integral color pigment added. The color pigment shall consist of a synthetic mineral oxide specifically manufactured for coloring concrete. The integral concrete coloring shall be obtained by mixing the pigment material with the Portland cement, aggregates, and water in a sequence and by methods that will result in a uniform mixture.

The color of the finished slope paving surfaces shall conform to Federal Standard Color No. 30324 as shown in Table II of Federal Standard No. 595a. The color shall conform to the referee color except that minor deviations in color and tint representative of the method of mixing and applying the slope paving will be acceptable.

Prior to placing slope paving for use in the work, the Contractor shall construct sufficient test panels to assure the Engineer that the proper color has been obtained and the final panel shall be at least four (4) feet by six (6) feet in size. The panels shall be constructed at the construction site and shall be placed by a method to be used in placing slope pavement.

The Engineer shall be the sole judge of compliance of the test panel construction with the texture and color requirements of these specifications.

Slope paving shall not be placed against frosted or frozen surfaces. If concrete is placed during cold weather it shall be heated and protected during placing and curing as set forth in Section 501, "Portland Cement Concrete," except concrete shall be maintained at a temperature of not less than fifty (50) degrees Fahrenheit for seventy-two (72) hours after placing and at not less than forty (40) degrees Fahrenheit for an additional four (4) days.

The slope paving shall be constructed without expansion joints.

The mesh reinforcing shall be placed so as to be in the approximate center of the concrete. All joints shall be lapped six (6) inches and run continuously throughout paving or between headers.

Concrete slope paving, aprons, and cutoff walls shall be cured as specified in Section 502, "Concrete Structures."

When the work is completed, the Contractor shall remove all debris from the jobsite.

METHOD OF MEASUREMENT

611.04.01 Measurement. The quantity of concrete slope paving including concrete aprons and cutoff walls measured for payment will be the number of cubic yards complete and in place.

The quantity will be computed from measurements of the actual areas placed based on the theoretical thickness shown on the plans. No additional allowance will be made for additional concrete placed by reason of low subgrades.

Each class of concrete will be considered separately, except where the Contractor elects to use either Class DA concrete in lieu of Class AA concrete or Class D concrete in lieu of Class A concrete, such Class DA concrete or Class D concrete shall be measured as Class AA concrete or Class A concrete.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

611.05.01 Payment. The accepted quantities of concrete slope paving, including aprons and cutoff walls in connection therewith measured as provided in subsection 611.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard for the material and class specified, which payment shall be full compensation for excavation, backfill, furnishing, and installing redwood headers, color pigment, concrete, and all labor, tools, equipment, and incidentals, and for doing all the work involved in placing the concrete slope pavement (including subgrade preparation forms and curing), complete in place, as shown on the plans, as specified herein, and as directed by the Engineer.

Reinforcement shall be measured and paid for as specified in Section 505, "Reinforcing Steel."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(class) Concrete Slope Pavement	Cubic Yard

16

SECTION 612

METAL BIN-TYPE RETAINING WALLS

DESCRIPTION

612.01.01 General. This work shall consist of furnishing and installing metal retaining walls of the bin type at the locations shown on the plans or designated by the Engineer and in reasonably close conformity to the lines, grades, basic designs, and dimensions shown on the plans or established by the Engineer.

The bin-type wall comprises prefabricated members with fittings and appurtenances for complete assembly in the field. The basic design of the wall refers to the length of wall spacers affecting depth of wall.

MATERIALS

612.02.01 General. The galvanized sheets used in fabricating the several members shall conform to the applicable requirements of AASHTO M218 (Zinc Coated Steel Sheets for Culverts and Underdrains). Bolts shall conform to ASTM A307, Grade A. Bolts, nuts, washers, and miscellaneous hardware shall be galvanized.

The various members shall be fabricated from specified metal of the respective gages shown on the plans, but not lighter than sixteen (16) gage. In the absence of given gages or dimensions for any member, fitting, or appurtenance, the gage of metal or dimensions thereof shall be as required to fully develop the strength of the members whose gages and dimensions are given and which are used in structural combination.

All members, fittings, and appurtenances shall be designed as integral units or parts of the whole assembly.

CONSTRUCTION

612.03.01 Fabrication. Metal bin-type retaining walls shall consist of a plurality of pairs of columns, one (1) column of each pair being in the plane of the front and the other column being in the plane of the rear of the wall, with the pairs of columns spaced longitudinally with overlapping S-shaped facing and rear members (stringer) and transversely with overlapping U-shaped tie members (spacers). The necessary bolts and appurtenances shall be furnished for complete assembly of the units into a continuous closed face wall of connected bins.

All members shall be so fabricated that members of the same nominal size shall be fully interchangeable. The members shall be so fabricated and punched that no drilling, punching, or drifting to correct defects in manufacture will be required during field assembling and any members having improperly punched holes will be rejected and shall be replaced with properly punched members.

612.03.02 Earthwork. Rough excavation for the site of the wall shall be made to the elevation of the finished ground line at the face of the wall. Below

this point, trenches eighteen (18) inches in width shall be excavated for the four (4) sides of the bin. The bearing of the base of the bin shall be firm and shall be approved by the Engineer before erection of the wall.

Structure excavation and backfill for the interior of the bin and behind the wall shall conform to the requirements of Sections 206, "Structure Excavation," and 207, "Backfill." Backfilling behind the wall shall progress with the filling of the bins and shall not be carried ahead of the binfill. Existing slopes, which are shaped so as to cause a wedge action in the backfill, shall be step-cut or benched before backfilling. The limiting dimensions of structure backfill behind the wall shall be the same as those prescribed in subsection 207.04.01 for walls and abutments, or as otherwise shown on the plans.

612.03.03 Assembly. In the construction of a wall on a curve the proper curvature for the face shall be obtained by the use of shorter stringers in the front or rear panels of retaining walls as designated in the plans or by the Engineer.

The wall height and depth may be varied. Two (2) or more designs of retaining walls may be incorporated in the same wall by the use of standard split columns to make the connection on the step-back.

The units shall be erected as shown on the plans. Members shall be handled carefully and any which are damaged shall be removed and new members substituted at the Contractor's expense.

METHOD OF MEASUREMENT

612.04.01 Measurement. The quantity of metal bin-type retaining wall measured for payment will be the number of square feet shown on the plans for each design type of wall, complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

612.05.01 Payment. The accepted quantities of metal bin-type retaining walls measured as provided in subsection 612.04.01, "Measurement," will be paid for at the contract unit price bid per square foot for the type specified.

Structure excavation and structure backfill will be paid for in accordance with Sections 206, "Structure Excavation," and 207, "Backfill."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Metal Bin-Type Retaining Wall (type)	Square Foot

SECTION 613

CONCRETE CURBS, GUTTERS, AND SIDEWALKS

DESCRIPTION

613.01.01 General. This work shall consist of constructing curbs, gutters, sidewalks, ramps, local depressions, and driveways of the form and dimensions shown on the plans of Class A or Class AA concrete as shown in the proposal, mixed and placed as provided in Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures," of these specifications with the following modifications and additional requirements.

The Contractor may, at his option, substitute Class D for Class A concrete or Class DA for Class AA concrete.

MATERIALS

613.02.01 General. Materials shall conform to the applicable requirements of Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures."

The epoxy adhesive used to bond concrete curbs to new or existing pavements shall conform to the requirements of ASTM C881, Type I, Grade 1, 2, or 3—Class A, B, or C.

CONSTRUCTION

613.03.01 Earthwork. The subgrade shall be constructed true to grade and cross section as shown on the plans or established by the Engineer. It shall be thoroughly watered and rolled or hand tamped until the subgrade reaches the compaction required for the adjacent roadway or base course. All soft and spongy material shall be removed to a depth of not less than six (6) inches below subgrade elevation for curbs, gutters, local depressions, and driveways and three (3) inches below for sidewalks, and the resulting space filled with earth, sand, or gravel of a quality that, when moistened and rolled or tamped, will form a firm and solid foundation.

The completed subgrade shall be tested for grade and cross section by means of a template extending the full depth and supported on the side forms. The subgrade and forms shall be thoroughly watered in advance of placing concrete.

613.03.02 Existing Curbs, Gutters, and Sidewalks. Where the limits of the new work fall within reasonable distance, as determined by the Engineer, to existing scoring lines or expansion joints, the Contractor shall remove existing concrete to those scoring lines or expansion joints. Where the limits of the new work do not fall within reasonable distance to existing scoring lines or expansion joints, the limits of the new work shall be saw cut and existing concrete shall be removed to the saw cut lines. Removal and replacement beyond the authorized limits shall be at the Contractor's expense and no additional compensation will be allowed therefor.

613.03.03 Forms. The depth of forms for curbs shall be equal to the full depth of the curb. The depth of outside forms for concrete gutters shall be equal to the full thickness of the gutter. Timber forms, if used, shall be surfaced on the side placed next to the concrete, and shall have a true smooth upper edge, and shall not be less than one and five-eighths (1 5/8) inches thick after being surfaced. Warped forms and forms not having a smooth, straight upper edge shall not be used.

Benders or thin plank forms, rigidly placed, shall be used on curves, grade changes, or for curb returns. Steel forms shall not be used on radii less than two hundred (200) feet.

Back forms for curb returns shall be made of one-half (1/2) inch benders, for the full height of the curb, cleated together. Forms shall be carefully set to alignment and grade and to conform to the dimensions required. Forms shall be held rigidly in place by the use of pairs of iron stakes placed at intervals not to exceed four (4) feet. If metal forms are used, iron stakes shall not be spaced more than six (6) feet apart. Clamps, spreaders, and braces shall be used where required to insure rigidity in the forms.

Forms shall not be removed until concrete has set sufficiently to prevent distorting or cracking.

All forms shall be cleaned thoroughly each time they are used and coated with a light oil as often as necessary to prevent the concrete from adhering to them.

613.03.04 Curb and Gutter Joints. Expansion joints one-half (1/2) inch wide shall be constructed in curbs and gutters at ninety (90) foot intervals, at each side of structures and at the ends of all curb returns except that expansion joints shall not be installed within twenty (20) feet of an island nose. Expansion joints shall be filled with joint filler strips one-half (1/2) inch thick conforming to the requirements of Section 707, "Joint Material," of these specifications. Expansion joint filler shall be shaped to the cross section of the curb and gutter.

Expansion joints shall be constructed at right angles to the line of the curb and gutter.

613.03.05 Sidewalk Expansion Joints. Transverse expansion joints one-half (1/2) inch wide shall be constructed at all sidewalk returns and opposite expansion joints in adjacent curb. Where curb is not adjacent, expansion joints shall be constructed at intervals of thirty (30) feet.

Expansion joints shall be filled with joint filler strips one-half (1/2) inch thick conforming to the requirements of Section 707, "Joint Material," of these specifications.

The joint filler shall be placed with the top edge one-fourth (1/4) inch below the surface and shall be held in place by means of steel pins driven into the subgrade and spaced sufficiently close to prevent warping of the filler during floating. Upon completion of floating, the pins shall be removed and when finishing operations have been completed, the joint shall be edged with an edging tool having a radius of one-eighth (1/8) inch.

613.03.06 Curb and Gutter Construction. In constructing curbs,

entrances for garages or driveways shall be constructed according to the dimensions shown on the plans.

With the approval of the Engineer, the curb may be constructed by the use of a curb forming machine.

The installation of precast concrete curbing shall meet the requirements herein prescribed.

Where plantmixed surfacing is to be placed around or adjacent to manholes, drop inlets, or catch basins in gutter, local depression, or driveway areas, such structures shall not be constructed to final grade until after the curbs and gutters have been constructed for a reasonable distance, as directed by the Engineer, on each side of the structure, in order to maintain a true grade for the surfacing to match.

Where Portland cement concrete pavement is to be placed around or adjacent to manholes, drop inlets, or catch basins in gutters, local depressions, or driveway areas, such structure shall not be constructed to final grade until after the concrete pavement has been constructed.

Concrete curbs to be constructed over new or existing pavements shall be anchored to the pavement with epoxy adhesive conforming to the requirements of subsection 613.02.01. If the curb is to be placed on new bituminous pavement, the pavement shall be cured for a minimum of two (2) weeks before bonding the curb thereon. Prior to placing the epoxy adhesive the pavement shall be thoroughly cleaned of all loose material, dirt, and dust and shall be dry. The mixed adhesive shall be applied in a strip extending full width and length of the curb.

The forms shall be filled to the top and the concrete shall be so handled that there will be no rock pockets. Concrete may be compacted by means of mechanical vibrators approved by the Engineer. Immediately after removing the front curb forms, the face of the curb shall be troweled smooth to a depth of not less than two (2) inches below the flow line or to the flow line of integral curb and gutter, and then finished with a steel trowel. The stop shall be finished and the front and back edges rounded as shown on the plans.

After the face of the curb has been troweled smooth, it shall be given a final fine brush finish with brush strokes parallel to the line of the curb.

The top and face of the finished curb shall be true and straight, and the top surface of curbs and gutters shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge ten (10) feet long is laid on the top or face of the curb or on the surface of gutters, the surface shall not vary more than one-eighth (1/8) inch from the edge of the straightedge, except at grade changes or curves.

The exposed surface shall be cured in accordance with the requirements of Section 502, "Concrete Structures."

613.03.07 Sidewalk Construction. The structures shall be finished to smooth and uniform texture by troweling and by floating with wooden floats, and, if so directed by the Engineer, by cross-brooming or burlap-finishing. The surface shall be lightly grooved or marked into squares or other shapes to match other such markings on similar existing structures in the vicinity, or as designated by the Engineer.

In the interest of creating a nonskid surface and an area readily identified by

the blind, the surface finish of ramps shall be rougher than the adjacent sidewalk. This may be accomplished by any means satisfactory to the Engineer.

When a ten (10) foot straightedge is placed on the sidewalk, the surface shall not vary more than one-eighth (1/8) inch from the edge of the straightedge, except at grade changes, and the finished surface shall be free from blemishes.

Immediately after the surface of the sidewalk is finished, the concrete shall be cured in accordance with the requirements of Section 502, "Concrete Structures."

METHOD OF MEASUREMENT

613.04.01 Measurement. The quantity of curb, glue down curb, gutter, shoulder strip, mountable curb, and combination curb and gutter measured for payment will be the number of linear feet along the base of the curb face or along the flow line of the gutter, and such measurement shall be continuous along such line extended across driveway and alley entrance returns.

The quantity of sidewalk, driveway, loading zone, and steps shall be measured for payment by area in square yards.

The quantity of ramps shall be measured for payment by area in square yards subject to the following limitation:

Measurement of areas to be included in the quantity to be paid for under the bid item of ramps shall be limited to those ramps constructed in existing sidewalk and curb and gutter areas where new sidewalks and curbs and gutters are not required to be constructed. The area of all ramps constructed in new sidewalk and curb and gutter areas shall be included in the new sidewalk bid item and the length of the depressed curb portion of the ramp shall be included in the new curb and gutter bid item.

In the case of integral curb and walk, the width of the walk shall extend to the back face of the curb. In the case of steps, the area measured shall be the summation of the areas of the treads, computed by multiplying the width of the tread by the length of the tread out to out of integral wall, if any.

All quantities measured for payment herein will be complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

613.05.01 Payment. The accepted quantities of concrete measured as provided in subsection 613.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for curb, glue down curb, gutter, shoulder strip, or mountable curb and per square yard for sidewalk, ramp, driveway, loading zone, or steps, as the case may be.

All excavation and base course work required for and performed during construction of the items of this section will be paid for as provided in the respective sections of the specifications; however, when the contract does not provide bid items for excavation or base course, such work required and performed will be considered subsidiary to the pay item contained herein and no further payment will be made therefor.

Saw cutting of existing installations prior to removal will not be paid for directly but the cost thereof shall be considered as included in the contract bid prices for other items of work.

Any excavation or backfill required other than roadway quantities will be considered subsidiary to the major items of work and no further payment will be made therefor.

Epoxy adhesive used to anchor "glue down" curbs to new and existing pavements as shown on the plans or ordered by the Engineer will not be paid for directly but the cost thereof shall be considered as included in the contract bid prices for other items of work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(class) Concrete Curb	Linear Foot
(class) Concrete Gutter	Linear Foot
(class) Concrete Curb and Gutter	Linear Foot
(class) Concrete Sidewalk	Square Yard
(class) Concrete Driveway	Square Yard
(class) Concrete Sidewalk and Driveway	Square Yard
(class) Concrete Scored Shoulder Strip	Linear Foot
(class) Concrete Mountable Curb	Linear Foot
(class) Concrete Loading Zones	Square Yard
(class) Concrete Ramp	Square Yard
(class) Concrete Glue Down Curb	Linear Foot

SECTION 614

PAINTING

DESCRIPTION

614.01.01 General. This work shall consist of the preparation of surfaces to be painted and the application, protection, and drying of the required number of coats of paint of the kinds and at the points specified or ordered by the Engineer.

Stay-in-place metal forms for bridge decks shall not be painted.

MATERIALS

614.02.01 General. All materials shall meet or exceed the minimum standards hereinafter set forth:

(a) Raw Materials. American Society for Testing and Materials (ASTM) and federal specifications.

(b) Prepared Paints. Federal specifications are specified to designate the type of material and standard of quality. Manufacturer's standard, first grade materials meeting or exceeding these requirements may be used if approved by the Engineer. Materials not bearing manufacturer's identification as a standard, first grade product, of his regular line, will not be considered.

(c) Proprietary materials when specified hereinafter by the manufacturer's trade name designate the standard of quality and type of material required. When the quality or type of material required is not specified, the Contractor shall apply for directions as to selection of materials and receive approval thereof from the Engineer before proceeding; only the best quality of such materials shall be used, as determined by the Engineer.

(d) Materials lists shall be submitted to the Engineer for approval and none shall be used until such approval has been obtained. All materials proposed for use shall be delivered to the site in original containers, seals unbroken, stored where directed, and none may be used until approved by the Engineer. Materials that are not approved must be immediately removed from the jobsite.

614.02.02 Number of Coats. Unless otherwise required in the contract documents, the number and kinds of coats of paint shall be as set forth in Section 714, "Paint."

CONSTRUCTION

614.03.01 Weather Conditions. Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather. Except as provided below, painting will not be permitted when weather conditions during applications are such that the atmospheric temperature is at or below forty (40) degrees Fahrenheit or when freshly painted surfaces may become damaged by rain, wind, dust, or condensation, or when it can be anticipated that the atmospheric temperature will drop below forty (40) degrees Fahren-

heit, during the drying period. If fresh paint is damaged by the elements it shall be replaced by the Contractor at his expense.

Subject to the approval of the Engineer in writing, the Contractor may provide suitable enclosures to permit painting during inclement weather. Provisions must be made to control atmospheric conditions artificially inside the enclosures within the limits suitable for painting throughout the painting operation. The cost of providing and maintaining such enclosures shall be considered as included in the prices paid for the various contract items of work and no additional payment will be made therefor.

614.03.02 Application—General. All work shall be done by painters and finishers of established status and reputation for executing their work by the very best methods for each kind or type. Painting shall not be done except when the surface is dry and when weather conditions are satisfactory as set forth above.

Strict adherence to these specifications and the recommendations of the manufacturer whose materials are used shall be followed in the application. The Contractor shall use such skills, equipment, materials, and give his thorough attention to details as will provide thoroughly workmanlike and satisfactory results throughout.

Work which shows carelessness, lack of skill and execution, or which is defective due to any other cause shall be removed and refinished or repainted as directed without additional cost to the State.

On all surfaces which are inaccessible for brushing, the paint shall be applied by sheepskin daubers especially constructed for the purpose, or by other means approved by the Engineer.

If spray methods are used, the operator shall be thoroughly experienced. Runs, sags, thin areas in the paint coat, or skips and holidays shall be considered as evidence that the work is unsatisfactory and the Contractor may be required to apply the remainder of the paint by brush.

Mechanical mixers shall be used to mix the paint. The paint shall be mixed a sufficient length of time, prior to use, to thoroughly mix the pigment and vehicle together. Paint shall be kept thoroughly mixed while being applied, to keep the pigments in suspension.

Paint specified or formulated shall be ready for application and thinning will be allowed only on direction of the Engineer.

The Contractor shall protect all parts of the structure being painted against disfigurement by spatters, splashes, and smerches of paint or paint materials. When paint is being applied on structures carrying public traffic, the Contractor shall be responsible for any damage caused by his operations to passing vehicles or persons and may be required to use canvas shields or other protective means to guard against such damage.

Paint stains which result in an unsightly appearance shall be removed by the Contractor at his own expense.

614.03.03 Surface Preparation of Steel. The following methods of surface preparation apply to steel surfaces. Unless otherwise specified, the sandblasting method shall be used.

(a) Sandblasting. All visible oil, grease, dirt, mill scale, rust, old paint,

and other foreign material shall be removed from steel surfaces by an approved blast cleaning apparatus. Blast cleaning shall be sufficient to meet the requirements of Steel Structures Painting Council, SSPC Specification SP–10, Photo Vis 1: C Sa 2½ Near-White.

Abrasives used for such blast cleaning shall be either clean dry sand, mineral grit, steel shot, or steel grit, at the option of the Contractor, and shall be of a grading suitable to produce satisfactory results. The use of abrasives other than those specified herein will not be permitted unless approved in writing by the Engineer.

When sandblasting is being performed on structures open to traffic, the Contractor shall provide suitable protective devices to prevent damage to traffic.

When sandblasting is being performed near machinery, all journals, bearings, motors, and moving parts shall be sealed against entry of sand dust before sandblasting begins.

Unless otherwise authorized by the Engineer, sandblasted surfaces shall be primed or treated the same day sandblasting is done. If cleaned surfaces rust before painting is accomplished, they shall be recleaned by the Contractor.

(b) Washes. Rust-inhibitor chemical washes shall be applied to freshly sandblasted steel surfaces prior to the application of the first undercoat of paint, except whenever the first undercoat of paint is applied to the cleaned surfaces within a four (4) hour period after cleaning, washes will not be required. Washes shall be applied in not more than four (4) hour intervals. If in the opinion of the Engineer, atmospheric conditions are such that corrosion products form on freshly sandblasted surfaces in less than four (4) hours, treatment may be required at more frequent intervals.

Rust-inhibitor chemical washes may be applied by brush or spray, and they shall be applied in a careful manner to insure that all surfaces are covered.

During the application of the rust-inhibitor chemical wash no sandblasting will be permitted to the areas being treated.

No paint shall be applied until after the treated surfaces have thoroughly dried.

The first undercoat of paint shall be applied to the treated surfaces the same day that cleaning and washing have been done.

(c) Steam Cleaning. All dirt, grease, loose chalky paint, or other foreign material which has accumulated on the previously painted surfaces shall be removed with an approved steam cleaning apparatus which shall precede all other phases of cleaning.

It is not intended that sound paint be removed by this process. Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case in less than twenty-four (24) hours after cleaning.

A detergent soap consisting of forty-five (45) percent sodium metasilicate, forty-three (43) percent sodium sesquisilicate, ten (10) percent sodium tetraphosphate and two (2) percent Naccanol shall be added to the feed water of the steam generator at the approximate rate of one (1) pound of detergent per two hundred (200) pounds of water.

Any residue which may accumulate on cleaned surfaces shall be removed by flushing with fresh water but washing down the cleaned surfaces will not otherwise be required.

(d) Hand Cleaning. All dirt, loose rust, and mill scale, dead paint, or paint which is not firmly bonded to the metal surfaces shall be removed by wire brushes, either hand or powered, hand scraping tools or sandpaper.

Pneumatic chipping hammers will not be allowed unless authorized in writing by the Engineer. Hand cleaning shall be sufficient to remove all loose material which would prevent the bond of succeeding coats of paint.

Hand cleaning will be permitted as an alternative to sandblasting on all steel except bridge girders. Bridge girders shall be cleaned by method (a), "Sandblasting," supplemented by minor amounts of hand cleaning as determined by the Engineer.

614.03.04 Painting Structural Steel. (a) Paint. The paint to be applied to the steel surfaces shall conform to the requirements of Section 714, "Paint," of these specifications. A minimum of three (3) coats of paint shall be required. The prime coat shall consist of a minimum dry film thickness of two (2) mils. The intermediate coat shall consist of a minimum dry film thickness of one and five-tenths (1.5) mils. The intermediate coat of paint shall be of such shade as to contrast with both the prime and finish coats. The finish coat shall consist of a minimum dry film thickness of one and five-tenths (1.5) mils. The total thickness of all coats shall not be less than five (5) mils.

Excessively thick coats of paint will not be permitted. The thickness of each coat shall be limited to that which will result in uniform drying throughout the paint film.

Prior to erection, all new structural steel shall be cleaned and painted with the prime coat of paint.

(b) Field Cleaning. Unless otherwise specified in the contract documents, after erection and riveting or welding, all surfaces of unpainted structural steel, which will be exposed to air, shall be sandblasted in accordance with the requirements of subsection 614.03.03, "Surface Preparation of Steel."

Any damage to sound paint, on areas not designated for treatment, resulting from the Contractor's operations, shall be repaired to the satisfaction of the Engineer.

(c) Painting. Painting of structural steel prior to erection will be limited to surface preparation and one (1) undercoat of paint. Any deficiencies in the first coat of paint shall be corrected to the satisfaction of the Engineer, prior to the application of succeeding coats of paint.

Surfaces exposed to the atmosphere which would be inaccessible for painting after erection shall be painted the full number of coats prior to erection.

The surface of the paint coat being covered shall be free from moisture, dust, grease, or any other deleterious material which would prevent the bond of the succeeding paint coats. In spot painting, any old paint which lifts after application of the first spot coat shall be removed by scraping and the area repainted before application of the next coat.

The application of the finish coat will not be permitted until the required total film thickness of the undercoats of paint, as described in (a), above, is obtained.

Open seams at contact surfaces of built-up members which would retain moisture shall be caulked with red lead paste before applying the second undercoat of paint.

Metal surfaces embedded in concrete need not be painted.

(d) Machine Finished Surfaces. With the exception of abutting chord and column splices and column and truss shoe bases, machine finished surfaces shall be coated with a rust inhibitor which can be easily removed. Surfaces of iron and steel castings which have been machine finished shall be painted with a coat of shop paint.

(e) Frames and Grates. Prior to installation, all surfaces of frames and grates exposed to the atmosphere shall be painted with two (2) coats of paint. Unless otherwise specified in the contract documents, the exposed surfaces shall be painted after installation with one (1) finish coat as specified for structural steel.

614.03.05 Painting Timber. (a) Paint. All new timber requiring painting shall be painted with three (3) coats of paint. The paint used for various coats will be as specified in these specifications or in the contract documents.

(b) Preparation of Surfaces. All cracked or peeled paint, loose chalky paint, dirt, and other foreign matter shall be removed by wire brushing, scraping, or other approved means immediately prior to painting. Unpainted timber shall be thoroughly dry before paint is applied.

(c) Painting. When permitted in writing by the Engineer, the first coat of paint may be applied prior to erection.

After the first coat has dried and the timber is in place, all cracks, checks, nail holes, etc., shall be puttied flush with the surface and allowed to dry before the second coat is applied.

Skips, holidays, thin areas, or other deficiencies in any one (1) coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.

The surface of the paint coat being covered shall be free of any deleterious material before any additional paint is applied.

BASIS OF PAYMENT

614.05.01 Payment. No direct payment will be made for painting, cleaning structural steel, or preparing surfaces for painting. Compensation for this work shall be considered as included in the contract unit prices bid for the particular item requiring painting.

SECTION 615

PRESERVATIVE TREATMENTS FOR TIMBER

DESCRIPTION

615.01.01 General. This work shall consist of preservative treatment for lumber, timber, and piles as herein specified.

MATERIALS

615.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set forth in these specifications.

Attention is directed to Section 719, "Timber Preservatives."

CONSTRUCTION

615.03.01 Treatment. All structural timber, piling, and other lumber shall be thoroughly seasoned or conditioned before treatment by air seasoning, kiln drying, steaming, or heating in the preservative, either at atmospheric pressure or under a vacuum, or by a combination thereof that will not cause damage. The moisture remaining in the wood, prior to treatment, shall be reduced so that the injection and proper distribution of the required amount of preservative will be obtained. The method of seasoning, conditioning, and treating used shall conform to the requirements of AASHTO M133.

615.03.02 Amount of Preservative. The minimum amount of preservative retained per cubic foot of timber, lumber, or piling shall conform to the minimum specification requirements of AASHTO M133.

Unless otherwise specified, material treated with pentachlorophenol shall have a minimum retention of one-half (½) of a pound per cubic foot of wood unless it is to be painted, then four-tenths (0.4) of a pound per cubic foot of wood will be the minimum retention.

Material to be treated with Ammoniacal Copper Arsenite shall have a net retention of dry salts of not less than three-tenths (0.3) pound.

615.03.03 Preservative Treatment by the Hot-Cold Soaking Method. When called for on the plans, all lumber and timber to be treated by the hot-cold soaking method must be reasonably well seasoned and free from outer and inner bark, dirt, grease, or other objectionable matter which will in any way hinder the free penetration of the preservative. All lumber and timber of two (2) inch dimensional stock or larger shall be incised and all framing shall be done before treatment.

The preservative used shall be a five (5) percent concentration of pentachlorophenol.

The tanks used shall be of sufficient size to permit complete submergence of the largest timber in any operation and to allow free circulation of the liquid

around the timber being treated. Sufficient liquid shall be maintained in the tank to completely submerge the timber to a minimum depth of six (6) inches. When a number of pieces are being treated at one time, each piece shall be separated from the others on all sides by spacers not less than one-fourth (1/4) inch in least dimension. Suitable weights or cross bracing shall be provided to keep the material submerged.

The timber or lumber shall be submerged in the cold solution as previously described. The temperature shall be slowly increased for a period of not less than five (5) hours to a minimum temperature of one hundred eighty (180) degrees Fahrenheit and not exceeding two hundred ten (210) degrees Fahrenheit. After five (5) hours and attaining the minimum specified temperature, the timber or lumber shall be permitted to cool in the solution until such time as the minimum specified quantity of preservative is absorbed by the wood.

Timber for minor irrigation structures, unless otherwise shown on the plans, shall be No. 1 common grade of the species permitted, and shall be treated in accordance with the hot-cold soak process. The species permitted and the minimum retention in pounds per cubic foot required are as follows:

Species	Min. Retention Per Cubic Foot (pounds)
Douglas Fir (Rocky Mountain, Inland, or Coast)	2.0
Pine, Yeilow (Pinus Ponderosa)	4.0
Pine, Lodge Pole (Pinus Contorta)	4.0
Cottonwood, Northern Black (Populas Trichocarpa Hastata)	4.0

615.03.04 Inspection. All timber and piling, untreated or to be treated, shall be inspected before treatment by an inspector designated by the Engineer. The inspector shall stamp each piece of timber accepted with a stamp making a legible mark designating the inspector.

All timber and piling shall be inspected after treatment by an inspector designated by the Engineer. The inspector shall stamp each piece accepted with a stamp making a legible mark designating the inspector.

All materials and processes used in the manufacture of material shall be subjected to inspection, acceptance, or rejection at the manufacturer's plant, which shall be equipped with all the necessary gages, appliances and facilities to enable the inspector to satisfy himself that the requirements of the specifications have been fulfilled.

The treated timber and piling shall be free from heat checks, water bursts, excessive checking, results of chafing, or from other damage or defects which would impair its usefulness or durability.

BASIS OF PAYMENT

615.05.01 Payment. Full compensation for treatment of lumber, timber, and piles as herein specified shall be considered as included in the price paid for the particular item of work in which the treated lumber, timber, or piling is used and no additional allowance will be made therefor.

SECTION 616

FENCING

DESCRIPTION

616.01.01 General. This work shall consist of furnishing and erecting new standard fence, chain-link fence, gates, or reconstructing fences previously removed, in conformity with these specifications and the plans.

New standard fence shall consist of galvanized barbed wire, galvanized farm fence, or both fastened to wood posts or metal posts or to a combination of the two kinds of posts as shown on the standard plans.

Chain-link fence shall consist of galvanized chain-link fabric attached to metal posts and fastened to a top tensioning cable and a bottom tensioning wire. The height of chain-link fences shall be as designated in the contract documents.

MATERIALS

616.02.01 General. Materials shall conform to the requirements specified in Sections 724, "Fence Materials," and 501, "Portland Cement Concrete."

CONSTRUCTION

616.03.01 General. All trees, brush, and other obstructions which interfere with proper construction of fences shall be removed and disposed of in accordance with the requirements of Section 201, "Clearing and Grubbing," of these specifications except that no payment will be made for such work. When constructing chain-link fence, rocks and other surface irregularities that require moving in order to maintain a nearly smooth surface, shall be removed and no direct payment will be made therefor.

Fence construction operations shall be so conducted as to prevent the escape of livestock. Existing cross fences shall be connected to the new fence. Corner posts, with braces for every direction of strain, shall be placed at the junction with existing fences and the wire in both fences properly fastened to the posts. At bridges and cattle passes, and at culverts if shown on the plans or ordered by the Engineer, the new fence shall be connected to the structure in such a manner as to permit the free passage of livestock through or under the structure.

Barbed wire, farm fence, and chain-link fence fabric shall be fastened on the side of the posts opposite the highway centerline unless otherwise directed by the Engineer.

Post holes for metal posts that are drilled or dug shall be backfilled with Class A or AA concrete or grout.

Each strand of barbed wire shall be securely fastened to a braced post at each intermediate braced post assembly by wrapping twice around the post then securing to that part of the same wire stretched between posts. The

remaining wire shall be cut off and the tie shall present a neat and workmanlike appearance.

Galvanized pipe brace rail shall not be spliced.

The first line of barbed wire above wire mesh shall be tied to the top wire of the wire mesh, midway between posts, with twelve (12) gage galvanized steel wire or nine (9) gage aluminum hog rings.

Intermediate Braced Post Assemblies—Timber. The horizontal brace shall be placed six (6) inches below the tops of the brace posts and properly fitted and connected to them by two (2) three-eighths (3/8) inch by four (4) inch steel dowels. The dowel pins shall extend two (2) inches into each brace and brace post. Two (2) strands of eight (8) gage galvanized wire shall be run as a brace diagonally from four (4) inches above ground line on each brace post to four (4) inches below the top of the other brace post. An extra loop shall be made around each post at the point of attachment and the wire firmly stapled to the post. These brace wires shall then be twisted until the assembly is rigid.

Corner post assemblies shall be constructed as indicated on the standard fence details and the end post assemblies shall be composed of end posts and brace posts installed and braced as indicated for timber corner braces.

At the option of the Contractor, timber line posts may be installed by tamping firmly in place in drilled or dug holes or by driving, provided the method of driving does not damage the posts or cause the posts to be deflected from line and plumb. All other timber posts shall be installed in drilled or dug holes and tamped firmly in place. Round timber posts installed in drilled or dug holes shall have the butt end placed downward. Timber line posts, which are to be driven, shall be machine pointed at the plant before being treated. The small end of driven round timber posts shall be pointed.

Each strand of barbed wire shall be securely fastened to a corner post, end post, or intermediate braced post assembly by wrapping twice around the post and securing to that part of the same wire stretched between the posts. The remaining wire shall be cut off and the tie shall present a neat and workmanlike appearance.

Staples shall be set so as to hold the wire securely, but should not be buried in the post in such a manner as to severely nick or bend the wire.

616.03.02 Standard Fence. Standard fencing shall be designated by types as follows: Metal posts—Type A; Wood posts—Type B; Combination metal and wood posts—Type C. The type of fence construction shall be as shown on the plans and indicated in the proposal. Posts shall be firmly set or driven into the ground and spaced as indicated on the plans. Each end, corner, and gate post shall be firmly braced and shall be set in concrete when required. Posts shall be braced as indicated on the plans.

Standard fencing will be designated not only by type, but also by a symbol indicating the fencing required. Thus (Type A–832–3B) will be used to designate a fence composed of metal posts, thirty-two (32) inch woven wire (farm fencing) and three (3) barbed wires; (Type C–726–4B) to designate a fence composed of a combination of metal and wood posts twenty-six (26) inch woven wire and four (4) barbed wires, etc. The figures 832, etc., when they appear in the symbol, correspond to design numbers set forth in the standard plan.

In general, in determining the post spacing, measurements will be made parallel to the slope of the natural ground, and all posts shall be placed in vertical position except in unusual locations where in the opinion of the Engineer it would be more satisfactory to place the posts perpendicular to the slope of the ground. All intervals shall be measured center to center of adjacent posts.

Changes in line where the angle of deflection is thirty (30) degrees or more shall be considered as corners and corner posts shall be installed. Changes in line where the angle deflection is more than fifteen (15) degrees and less than thirty (30) degrees shall be considered as alignment angles and adjacent posts shall be made fast to the angle posts by means of wire, or if such method is impracticable in the opinion of the Engineer, such posts shall be braced as above specified for bracing gate, end, and corner posts.

At all grade deflections and alignment angles where stresses tend to pull the posts from the ground, the fencing shall be snubbed or guyed at the critical point by means of a double strand of nine (9) gage galvanized wire connected to each horizontal line of barbed wire or to the top and bottom of wire mesh fabric, and to a deadman weighing approximately one hundred (100) pounds, buried in the ground not less than two (2) feet. The fencing shall be pulled snug close to the ground before being snubbed or guyed.

Barbed wire and farm fence fabric (woven wire) shall be stretched taut and securely fastened to each post by means of suitable devices approved by the Engineer.

616.03.03 Chain-Link Fence. All posts shall be of a total length of not less than the depth of the concrete footing as shown on the plans, plus the length required above ground.

Changes in line where the angle of deflection is thirty (30) degrees or more shall be considered as corners and corner posts shall be installed.

Between posts, chain-link fences shall be fastened to a bottom tension wire and a top tension cable. The bottom tension wire shall be at least seven (7) gage galvanized coil spring wire of good commercial wire. The top tension cable shall be at least three-eighths (3/8) inch diameter galvanized seven (7) strand cable conforming to the requirements of the current ASTM Designation A475 common grade.

Line posts shall be spaced at not more than ten (10) foot intervals, measured from center to center of posts. In general, in determining the post spacing, measurements will be made parallel to the slope of the natural ground, and all posts shall be placed in a vertical position except in unusual locations where in the opinion of the Engineer it would be more satisfactory to place the posts perpendicular to the slope of the ground.

All metal posts shall be set in Class A or AA Portland cement concrete footing crowned at the top to shed water. Depths of footings shall be as shown on the plans.

End, corner, and gate posts shall be braced with galvanized braces used as compression members and galvanized steel truss rods with truss tighteners used as tension members. Line posts, at intervals of five hundred (500) feet, shall be braced and trussed in both directions as shown on the plans.

The fabric shall be stretched taut and securely fastened to the posts, and

between posts the top edge of the fabric shall be fastened to the top tension cable and the lower edge fastened to the bottom tension wire. Tension cable and wire shall be stretched tight with truss tightener as shown on the plans. The bottom tension wire shall be installed on a straight grade between posts by excavating the high points of the ground and in no case will filling of depressions be permitted.

The fabric shall be fastened to the end, corner, gate posts, and intermediate braced posts with one-fourth (1/4) by three-fourths (3/4) inch steel stretcher bars and not less than one-eighth (1/8) by three-fourths (3/4) inch steel stretcher bar bands placed at one (1) foot intervals, and to line posts tension cable and tension wires with tie wires or metal bands. Tie wires or metal bands shall be spaced on line posts at intervals of approximately fourteen (14) inches and on tension cables and tension wires approximately eighteen (18) inches.

All posts shall be fitted with tops designed so as to fit securely over the posts, and carry the top tension cable, except that the top of the C-section posts may be open-slotted in such a manner as to securely hold the top tension cable in position without vertical movement. Such slotting shall allow removal and replacement of a post without disturbing the top tension cable. Tubular posts shall be fitted with watertight tops.

The Contractor may, at his option, use either pipe or C-section posts. However, the same post type shall be used for all chain-link fence. If the Contractor elects to use C-section line posts, corner or end posts may be either Type II terminal posts or two and three hundred seventy-five one-thousandths (2.375) inches outside diameter galvanized pipe weighing not less than three and sixty-five one-hundredths (3.65) pounds per foot.

616.03.04 Reconstruct Fence. Reconstructed fences shall be carefully erected, using salvaged materials, and shall be similar in type to the original construction. Any new materials necessary to rebuild the fence shall be furnished by the Contractor, shall be of the same kind as those in the original fence, and the cost thereof shall be included in the contract price for the work. The resulting reconstructed fence shall be equal to or better than before removed. In reconstructed fences, the Department reserves the right to furnish the Contractor with such new materials as it deems advisable, and these materials shall be used in the reconstruction of the fence in lieu of salvage materials which they replaced.

616.03.05 Gates. The width of drive gates shall be as shown on the plans and as indicated in the proposal and the height shall be suited to the fencing but shall not be more than seventy-two (72) inches nor less than forty-eight (48) inches. The wire mesh filler shall be rectangular or two (2) inch diamond mesh for standard fencing and chain-link fence fabric for chain-link fencing.

Walk gates shall be three and one-half (3 1/2) feet wide and of a height corresponding to the adjacent fence height.

The gates shall be hung by steel or malleable iron hinges so designed as to securely fasten to the gate posts and permit the gate to swing back against the fence.

Gates shall be provided with a combination steel or malleable iron catch and

locking-in attachment of approved design. A center rest with catch shall be provided where required.

Missouri gates shall be constructed as shown on the standard plan.

METHOD OF MEASUREMENT

616.04.01 Measurement. The quantity of new fence measured for payment will be the number of linear feet, exclusive of gates and cattle guards, complete and in place.

The quantity of reconstructed fence measured for payment will be the number of linear feet, including used gates complete and in place.

The quantity of new gates measured for payment will be the number of gates complete and in place. If more than one (1) size or type of gate is involved, separate measurement will be made for each size and type given.

Missouri gates, regardless of width, shall be measured for payment as units.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

616.05.01 Payment. The accepted quantity of new and reconstructed fence measured as provided in subsection 616.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

The accepted quantity of new gates measured as provided in subsection 616.04.01, "Measurement," will be paid for at the contract unit price bid per each for types and sizes specified.

The above prices shall be full compensation for furnishing hardware, cement, concrete, framing, erecting, connecting fence, and all incidentals necessary to complete the work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Type ( ) Fence	Linear Foot
(size) Chain-Link Fence	Linear Foot
(size) Metal Drive Gate	Each
(size) Timber Drive Gate	Each
(size) Metal Walk Gate	Each
(size) Timber Walk Gate	Each
Reconstruct Fence	Linear Foot
Missouri Gate	Each

SECTION 617

CATTLE GUARDS

DESCRIPTION

617.01.01 General. This work shall consist of furnishing and constructing standard steel cattle guards and cattle guard wings of the design and at points shown on the plans or ordered by the Engineer.

MATERIALS

617.02.01 General. All materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505
Steel Structures	Section 506
Hardware	Section 723
Painting	Section 614
Paint	Section 714

Portland cement concrete shall be Class A or Class AA, unless otherwise provided.

All hardware shall be galvanized steel.

All lumber and timber shall be Douglas Fir, No. 2 joist and plank, or No. 1 structural posts and timber. Any commercial grading rules that will provided material of an equal or greater stress value may be used.

CONSTRUCTION

617.03.01 Earthwork. Structure excavation and backfill shall conform to the applicable requirements of Sections 206, "Structure Excavation," and 207, "Backfill."

617.03.02 General. Cattle guards shall be constructed in accordance with the details and dimensions shown on the plans.

Concrete and metal reinforcement construction shall conform to the applicable requirements of Sections 502, "Concrete Structures," and 505, "Reinforcing Steel," respectively.

Steel member connections shall be welded and the construction thereof shall conform to Section 506, "Steel Structures."

Structural steel for cattle guards shall be unpainted or may be given one (1) shop coat of primer after fabrication at the Contractor's option.

The wing posts and wheel guards shall be given a preservative treatment conforming to the requirements of Section 719, "Timber Preservatives." Treated timber and lumber is not to be painted.

Timber and lumber shall be assembled and placed in conformance to the applicable requirements of Section 507, "Timber Structures."

Painting shall be in accordance with recognized high standards of workman-

ship and in conformance with the applicable requirements of Section 614, "Painting."

All untreated timber and lumber shall be painted as specified herein.

METHOD OF MEASUREMENT

617.04.01 Measurement. The quantity to be measured for payment will be the number of steel cattle guards or cattle guard wings complete and in place. If more than one (1) size of cattle guard is involved, separate measurement will be made of each size given.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

617.05.01 Payment. The accepted quantity of cattle guards measured as provided in subsection 617.04.01, "Measurement," will be paid for at the contract unit price bid per each for the sizes specified. The cost of cattle guard wings shall be included in the contract unit price for cattle guards, however, where wings alone are required, they will be paid for at the contract unit price each for cattle guard wings. The above prices shall be full compensation for furnishing hardware, cement concrete, steel, timber and lumber, structure excavation and backfill, furnishing and applying paint, framing, erecting, adjusting fence, and all incidentals necessary to complete the work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Steel Cattle Guard	Each
Cattle Guard Wings	Each

SECTION 618

GUARDRAIL

DESCRIPTION

618.01.01 General. This work shall consist of furnishing and erecting new guardrail, breakaway cable terminals and additional guardrail beam elements required for constructing double beam rail, or reconstructing guardrail previously removed, in conformity with these specifications and of the types and at the points shown on the plans or ordered by the Engineer. This item shall also consist of furnishing and installing reflector plates as shown on the plans.

This work shall also include the furnishing and installation of galvanized guardrail (triple corrugations) in accordance with the plans, as stated herein and as directed by the Engineer.

Guardrail quantities shown on the plans are approximate. As construction progresses the Engineer will review the need for guardrail and will, at the completion of this review, provide the Contractor with the revised amount of guardrail required. Should the Contractor elect to order guardrail materials prior to receiving this revised list from the Engineer he shall be completely responsible for furnishing the amount of guardrail and appurtenances required by said list. Should additional quantities be required to meet the requirements of the list there shall be no additional compensation allowed above the unit price bid and no compensation shall be allowed for surplus materials in excess of the requirements of the list.

MATERIALS

618.02.01 General. All material shall conform to the requirements specified in the following sections:

Timber	Section 718
Timber Preservatives	Section 719
Guardrail Materials	Section 720
Galvanizing	Section 715

Except as hereinafter provided, the Contractor shall have the option of using wood or metal posts and blocks. The exception to the foregoing is that the use of wood posts is mandatory for "breakaway cable terminal" as shown on Standard Plan Sheet No. R–8.1.6.

Except as provided above, the type of post selected shall be used for the entire project and a combination of wood and metal posts shall not be allowed.

Except as hereinafter provided, metal posts, blocks, and brackets shall conform to the details shown on the plans. All metal posts, blocks, and brackets shall be galvanized after fabrication in accordance with Section 715 of these specifications.

Wood guardrail posts and blocks shall be rough construction grade and shall comply with the grading requirements of subsection 718.03.02.

Each wood post and block, after fabrication, shall be given a preservative treatment by pressure processes with one (1) of the following in accordance with the provisions of Section 615, "Preservative Treatments for Timber."

The minimum retention of preservative in pounds per cubic foot of wood shall be as follows:

(a) Creosote—eight (8) pounds.

(b) Creosote-Petroleum—eight (8) pounds.

(c) Pentachlorophenol—five-tenths (0.5) pounds.

618.02.02 Reflectors. Reflector plates shall be constructed and erected on all guardrail in accordance with the details shown on the plans.

The spacing of the reflector plates to be erected on the spacer blocks for guardrail installations shall be the same as for guide posts as shown on Standard Plan Sheets No. R–8.1.1 and No. R–9.1.1.

The color of the reflector plates shall be as noted on Standard Plan Sheet No. R–9.1.1.

CONSTRUCTION

618.03.01 General. Unless otherwise specified, guardrail shall be constructed with either treated Douglas Fir, West Coast Hemlock, or Western Larch posts, beam-type plates and fittings, as shown on the plans. Post spacing shall be as shown and guardrails shall be constructed in accordance with the design shown on the plans. The use of more than one (1) type of guardrail on a single project will not be approved unless so provided in the special provisions or appearing as a contract item in the proposal.

Posts shall be set plumb, except on superelevated curves where they shall be set perpendicular to the roadbed. Front faces of posts shall form a straight line, except on curves where they shall be a uniform distance from the centerline of the roadway. Post holes shall be backfilled in layers with approved material thoroughly rammed with an iron tamping tool in such manner as not to displace the bottom of posts from correct alignment.

Guardrail beam elements may be furnished in twelve and one-half (12½) foot or twenty-five (25) foot lengths at the option of the Contractor.

Workmanship shall be first class in all respects and framing shall be done and fittings attached in such manner that the rail, after erection, shall be true to line and grade and shall have the proper tension in the rail plates. Care shall be taken to prevent the disturbance of posts during the erection of the rail, and, when necessary, temporary braces shall be installed to insure against post displacement.

618.03.02 Blank.

618.03.03 Galvanized Guardrail. The guardrail beam elements and end sections shall be galvanized. Galvanizing shall be performed after fabrication. Fabrication shall include all operations such as shearing, cutting, punching, forming, drilling, milling, and bending.

Galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired by thoroughly wire brushing

the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with two (2) coats of paint, high zinc dust content, conforming to the requirements of Federal Specification MIL–P–21035.

All exposed surface of the metal guardrail that has become soiled shall be cleaned, at the expense of the Contractor, as required by the Engineer.

Galvanized guardrail shall not be painted.

618.03.04 Reconstructed Guardrail. Reconstructed guardrail shall be carefully erected using salvaged materials and shall be similar in type to the original construction. Any new materials necessary to rebuild the guardrail shall be furnished by the Contractor, shall be of the same kind as those in the original, if available, and the cost thereof shall be included in the contract price for the work. The Department reserves the right to furnish the Contractor with such materials as it deems advisable, and these materials shall be used in the reconstruction of the guardrail in lieu of salvage materials which they replaced.

METHOD OF MEASUREMENT

618.04.01 Measurement. The quantity of new or reconstructed guardrail measured for payment will be the number of linear feet measured along the front face of the rail between centers of posts complete and in place. Breakaway cable terminals, guardrail-bridge rail connections, or guardrail-barrier rail connections, measured as provided in this subsection, shall not be included in the linear foot measurement of new or reconstructed guardrail.

The additional guardrail beam elements required to construct the double beam rail at locations shown on the plans shall be measured for payment by the linear foot measured along the face of the additional rail between centers of end posts.

Breakaway cable terminals will be measured for payment as units. The units shall include the end section, the first two (2) posts and the W-beam element. Attention is further directed to the drawing "bid item—breakaway cable terminal" on Standard Plan Sheet No. R–8.1.6, which further depicts the unit of measurement.

The quantity of guardrail-bridge rail or guardrail-barrier rail connections will be measured for payment as units.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

618.05.01 Payment. The accepted quantity of new and reconstructed guardrail measured as provided in subsection 618.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot.

The above prices shall be full compensation for furnishing hardware, reflectors, erecting, galvanizing, and all incidentals necessary to complete the work.

The accepted quantity of "(type) Guardrail Beam Elements" measured as

provided above will be paid for at the contract unit price bid per linear foot of double beam rail, which price shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved in constructing the double beam rail complete in place.

Breakaway cable terminal will be paid for at the contract unit price bid per each, which payment shall be considered full compensation for the end section terminal element, twelve (12) foot six (6) inch rail element, terminal connector, cable, fittings, anchor plate, posts, bolts, nuts, washers, structure excavation, concrete, reinforcement, polystyrene foam sheeting, and for doing all the work involved to install the breakaway cable terminal complete in place in the accepted work.

The accepted quantity of "Guardrail-Bridge Rail Connections" or "Guardrail-Barrier Rail Connections" will be paid for at the contract unit price bid per each and shall include the terminal connector, the twelve (12) foot six (6) inch guardrail panel and all spacer blocks and hardware and for doing all work involved to install the guardrail-bridge rail or guardrail-barrier rail shall be measured and paid for in accordance with Section 502, "Concrete Structures."

It shall be understood and agreed that the use of wood or steel posts and blocks and the use of a heavier steel beam are provided solely for the Contractor's convenience and there shall be no adjustment in the contract unit price bid per linear foot for guardrail due to these options.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Galvanized Guardrail	Linear Foot
Galvanized Guardrail (Triple Corrugations)	Linear Foot
Reconstruct Guardrail	Linear Foot
(type) Guardrail Beam Elements	Linear Foot
Breakaway Cable Terminal	Each

SECTION 619

OBJECT MARKERS AND GUIDE POSTS

DESCRIPTION

619.01.01 General. This work shall consist of furnishing and installing object markers and guide posts of the design and at locations shown on the plans or established by the Engineer.

MATERIALS

619.02.01 General. Materials shall conform to the requirements specified in Section 721, "Object Markers and Guide Posts."

CONSTRUCTION

619.03.01 General. Target members and reflectors appropriate to the color involved shall be assembled, fastened, set, and aligned in accordance with the details and dimensions shown on the plans. All fastenings shall be tight.

Object markers shall be assembled, fastened, set, and aligned in accordance with the details and dimensions shown on the plans. Reflectors shall be installed when required as indicated. The exact locations will be determined by the Engineer.

619.03.02 Reset. Reset object markers and guide posts shall be carefully erected, using salvaged materials, and shall be similar in type to the original construction. Any new materials necessary to rebuild the markers shall be furnished by the Contractor, shall be the same kind as those in the original, if available, and the cost thereof shall be included in the contract price for the work. The Department reserves the right to furnish the Contractor with such new materials as it deems advisable, and these materials shall be used in the resetting of the markers in lieu of salvage materials which they replaced.

METHOD OF MEASUREMENT

619.04.01 Measurement. The quantity of new or reset object markers or guide posts measured for payment will be the number of markers or guide posts ordered by the Engineer and placed by the Contractor.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

619.05.01 Payment. The accepted quantity of new and reset object markers and guide posts measured as provided in subsection 619.04.01, "Measurement," will be paid for at the contract unit price bid per each, which price shall be full compensation for furnishing hardware, erecting, and incidentals necessary to complete the work.

When the Engineer orders guide posts placed for the protection of the public traffic, and such order is prior to the time the Contractor would normally install them, and some posts subsequently are damaged by public traffic, the Contractor shall replace the damaged posts with new ones and receive compensation at the contract unit bid price for both the damaged posts and the ones replaced.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Guide Posts	Each
Reset Guide Posts	Each
Object Markers, Type 1	Each
Object Markers, Type 2	Each
Object Markers, Type 3	Each
Reset Object Markers	Each

SECTION 620

RIGHT OF WAY MARKERS

DESCRIPTION

620.01.01 General. This work shall consist of furnishing and erecting right of way markers conforming to these specifications and of the design shown on the plans or ordered by the Engineer.

MATERIALS

620.02.01 General. Right of way markers shall consist of metal posts and metal plates conforming to the requirements of Standard Plan Sheet No. R–9.2.1 and the post shall be galvanized after fabrication.

CONSTRUCTION

620.03.01 General. Right of way markers shall be constructed in accordance with the details and dimensions shown on the plans. The markers shall be set plumb.

The exact location of posts will be staked by the Engineer.

METHOD OF MEASUREMENT

620.04.01 Measurement. The quantity of right of way markers measured for payment will be the number of markers complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

620.05.01 Payment. The accepted quantity of right of way markers measured as provided in subsection 620.04.01, "Measurement," will be paid for at the contract unit price bid per each.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Right of Way Markers	Each

17

SECTION 621

MONUMENTS

DESCRIPTION

621.01.01 General. This work shall consist of furnishing and installing Portland cement concrete reference monuments and metal marker posts of the design and at locations shown on the plans or ordered by the Engineer.

This work shall also consist of furnishing and installing Portland cement concrete survey monument bases complete with galvanized pipe risers and either welded steel or cast iron covers, all as indicated on the plans and as directed by the Engineer.

Bronze disks furnished by the Department shall be installed in the monuments.

MATERIALS

621.02.01 General. Materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Fence Materials	Section 724

The six (6) inch galvanized steel pipe riser for survey monuments shall conform to the requirements of ASTM Designation A120, Schedule 40.

Steel used in the fabrication of the welded steel cover for survey monuments shall conform to the requirements of ASTM Designation A36. Welding shall conform to the requirements of Section 506 of these specifications.

The cast iron cover for survey monuments shall conform to the requirements of subsection 712.03.02 of these specifications.

CONSTRUCTION

621.03.01 Installation. Monuments shall be constructed of Class A or AA Portland cement concrete, in accordance with the applicable provisions of Section 502, "Concrete Structures."

Reference monuments shall be set to assist in reestablishment of the centerline for future use and shall be set at the beginning and end of each project, at the beginning and end of each curve, and approximately one-half (1/2) mile apart on long tangents.

Reference monuments, located as outlined above, shall be established outside construction limits, and the exact location will be that determined by the Engineer.

A hole just large enough for the reference monument shall be excavated for the required depth. If solid rock is reached before the required depth is reached, the monument may be built on this instead of being built to its full depth. This hole shall be filled with the concrete. When the concrete has set sufficiently, the bronze disk shall be installed in the exact position required by the Engineer.

Metal marker posts for reference monuments shall be "T" rail steel fence posts complete with an anchor and not less than five (5) feet in length, weighing not less than one and three-tenths (1.3) pounds per foot. The posts shall be galvanized or painted with anti-corrosive paint. The posts shall be driven to the depths indicated or ordered and shall be located adjacent to the reference monument.

Survey monuments shall be set at locations shown on the plans as directed by the Engineer. Marker posts are not required.

METHOD OF MEASUREMENT

621.04.01 Measurement. The quantity of reference monuments or survey monuments measured for payment will be the number of units complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

621.05.01 Payment. The accepted quantity of monuments measured as provided in subsection 621.04.01, "Measurement," will be paid for at the contract unit price bid per each, which price shall include concrete, metal marker posts, pipe risers and covers, excavation, backfill, and disposing of any surplus material.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Reference Monuments	Each
Survey Monuments	Each

SECTION 623

SIGNALS AND LIGHTING

DESCRIPTION

623.01.01 General. Electrical work shall consist of furnishing and installing, modifying or removing one (1) or more traffic signals, flashing beacon systems, highway lighting systems, sign illumination systems, traffic count stations, electrical equipment in structures, falsework lighting, partial installations for future systems, or combinations thereof, all as shown on the plans, and as specified in these specifications and the special provisions.

The locations of signals, beacons, standards, lighting fixtures, signs, controls, services, and appurtenances shown on the plans are approximate and the exact locations will be established by the Engineer in the field.

All materials furnished and used shall conform to the provisions in Section 106, "Control of Materials." The materials shall be manufactured, handled, and used in a workmanlike manner to insure completed work in accordance with the plans, specifications, and special provisions.

All systems shall be complete and in satisfactory operating condition at the time of acceptance of the contract.

Where an existing system is to be modified, the existing material shall be reused in the revised system, removed, salvaged, and stockpiled or abandoned as shown on the plans, as specified in the special provisions or as directed by the Engineer.

623.01.02 Regulations and Code. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), the Underwriters' Laboratories, Inc. (UL), or the Electronic Industries Association (EIA), wherever applicable. In addition to the requirements of the plans, these specifications, and the special provisions, all materials and workmanship shall conform to the requirements of the National Electrical Code, hereinafter referred to as the Code; Rules for Overhead Electrical Line Construction, the Public Service Commission; Standards of the American Society for Testing and Materials (ASTM); American National Standards Institute (ANSI); International Municipal Signal Association (IMSA); Illumination Engineering Society (IES); Rural Electrification Association (REA); and any local ordinances which may apply.

Wire sizes shall be based on American Wire Gage (AWG).

623.01.03 Equipment List and Drawings. Unless otherwise permitted in writing by the Engineer, the Contractor shall, within fifteen (15) days following approval of the contract, submit to the Engineer for approval a list of equipment and materials which he proposes to install. The list shall be complete as to name of manufacturer, size, and identifying number of each item. The list shall be supplemented by such other data as may be required, including scale drawings of cabinets showing location and spacing of shelves, terminal blocks, and equipment, including dimensioning. All of the above

data shall be submitted in triplicate for review. Where electrical equipment is constructed as detailed on the plans, the submission of detailed drawings and diagrams will not be required.

Where a basic controller cabinet wiring diagram is provided, circuit diagrams for detector plug connections, peripheral equipment, and external solid-state logic shall be provided.

The Contractor shall furnish to the Engineer for transmittal to the maintaining agency one (1) reproducible film positive with silver base, and one (1) copy thereof, of the cabinet schematic wiring diagram for each controller cabinet furnished. The diagrams shall show the location of the installation and shall list all equipment installed in each cabinet. In addition, for each signal installation, the Contractor shall furnish an intersection sketch showing poles, detectors, field wire connection terminals, and phasing as shown on the plans. One (1) copy of the controller cabinet diagram and the intersection and phase diagram as reviewed by the Engineer shall be placed in a heavy duty plastic envelope with side opening, and attached to the inside of the door of each controller cabinet.

All schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams, and all operation manuals shall be submitted at the time the controllers are delivered for testing or, if ordered by the Engineer, previous to purchase. This diagram shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

623.01.04 Warranties, Guarantees, and Instruction Sheets. Manufacturers' warranties and guarantees furnished for materials used in the work and instruction sheets and parts lists supplied with materials shall be delivered to the Engineer prior to acceptance of the project.

623.01.05 Maintaining Existing and Temporary Electrical Systems. Existing electrical systems (traffic signal, ramp metering, highway and street lighting, flashing beacon, and sign illumination), or approved temporary replacements thereof, shall be kept in effective operation for the benefit of the travelling public during the progress of the work, except when shutdown is permitted to allow for alterations or final removal of the systems. The traffic signal shutdowns shall be limited to periods during normal working hours, or shall be as specified in the special provisions. Lighting system shutdowns shall not interfere with the regular lighting schedule, unless otherwise permitted by the Engineer. The Contractor shall notify the Engineer prior to performing any work on existing systems.

The local traffic enforcement agency and the traffic signal maintenance agency shall be notified prior to any operational shutdown of a traffic signal system.

State or local forces will continue operation and maintenance of existing electrical facilities. The State or local authorities will furnish electrical energy for operation and will repair or replace damaged facilities.

Where damage is caused by the Contractor's operations, the Contractor shall, at his expense, repair or replace damaged facilities promptly in accordance with these specifications. Should the Contractor fail to perform the

required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any moneys due or to become due the Contractor.

The exact location of existing conduit runs and pull boxes shall be ascertained by the Contractor before using equipment that may damage such facilities or interfere with any system.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the lighting systems shall remain in operation and the final connection to the modified circuit shall be made so that the modified circuit will be in operation by nightfall of the same day.

Temporary electrical installations shall be kept in effective operation until the temporary installations are no longer required for the travelling public. Removal of temporary installations shall conform to the provisions in subsections 623.03.15, 623.03.16, and 623.03.17, "Salvaging and Reinstalling or Stockpiling Electrical Equipment."

These provisions will not relieve the Contractor in any manner of his responsibilities as provided in subsection 107.11, "Responsibility for Damage," and subsection 107.16, "Contractor's Responsibility for the Work and Materials."

A temporary overhead cable system may be used for the existing signal system circuitry in lieu of maintaining the underground installations during construction.

Where an existing system is being modified, work not shown on the plans or specified in the special provisions and which is considered by the Engineer as necessary to keep all or any part of the existing system in effective operation shall be considered as included in the prices paid for the systems, or units, therefor no additional compensation will be allowed.

623.01.06 Scheduling of Work. Work shall be so scheduled that each traffic signal, highway lighting, and sign illumination system shall be completed and ready for operation prior to opening the corresponding section of the roadway to traffic.

Traffic signals shall not be placed in operation for use by public traffic without the energizing of street lighting at the intersection to be controlled if street lighting exists or is being installed in conjunction with the traffic signals.

Traffic signals shall not be placed in operation until the roadways to be controlled are open to public traffic, unless otherwise directed by the Engineer.

Highway lighting and traffic signals shall not be placed in operation, including flashing operation, prior to commencement of the functional test period specified in subsection 623.02.14, "Field Tests," unless ordered otherwise by the Engineer.

Conductors shall not be pulled into conduit until pull boxes are set to grade, crushed rock sumps installed, mortar placed around conduit, concrete bottom of pull boxes placed, and metallic conduit bonded.

Unless otherwise directed by the Engineer, traffic signals at new locations shall be placed on flashing operation for a minimum of twenty-four (24) hours prior to normal operation.

In vehicular undercrossings, soffit lights shall be placed in operation as soon as practicable after falsework has been removed from the structure. Lighting for pedestrian structures shall be placed in operation prior to opening the structure to pedestrian traffic.

If the Engineer orders soffit lights or lighting for pedestrian structures placed in operation before permanent power service is available, the cost of installing and removing temporary power service will be paid for as extra work as provided in subsection 104.03, "Extra Work."

623.01.07 Safety Precautions. Before starting work on existing series street lighting circuits, the Contractor shall obtain daily a safety circuit clearance from the serving utility. Bypass switch plugs shall be pulled and "Men at Work" signs posted at switch boxes before any work is done.

623.01.08 Definitions. The following definitions pertain only to Section 623, "Signals and Lighting."

Actuation. The operation of any type of detector.

Clearance Interval. The interval(s) from the end of the right of way of one (1) phase to the beginning of a conflicting phase.

Controller. The complete electrical mechanism for controlling the operation of a traffic signal. A controller consists of a controller unit and all auxiliary equipment housed in a weatherproof cabinet.

Controller Unit. The basic timing unit of a traffic signal controller with its manually variable sequence and timing controls.

Detector for Traffic Actuation. A device by which vehicles or pedestrians are enabled to register their presence with a traffic actuated signal controller.

Magnetic Vehicle Detectors. A detector installed in or near the roadway, capable of being actuated by the induced voltage caused by the passage of a vehicle through the earth's magnetic field.

Magnetometer Vehicle Detector. A detector installed in or near the roadway, capable of being actuated by the magnetic disturbance caused by the passage or presence of a vehicle.

Inductive Loop Detector. A detector installed in the roadway capable of being actuated by the change of inductance caused by a vehicle passing over or standing over the loop.

Pedestrian Detector. A detector, usually of the push button type, installed near the roadway and capable of being operated by hand.

Pressure-Sensitive Vehicle Detector. A detector installed in the roadway capable of being actuated by the pressure of a vehicle passing over its surface.

Electrolier. The complete assembly of pole, mast arm, luminaire, ballast, and lamp.

Extensible Portion. That portion of the green interval on an actuated phase following the initial portion which may be extended, for example, by traffic actuation.

Extension Limit. The maximum time for which actuations on any traffic phase may retain the right of way after actuation on an opposing traffic phase, after the initial portion has been timed out.

Flashing Feature. A device which, when operated, discontinues normal

signal operation and causes the flashing of any predetermined combination of signal lights.

Initial Portion. The first part of the green interval which is timed-out or separately controlled by a traffic-actuated controller before the extendible portion of the interval takes effect.

Interval. Any one (1) of the several divisions of the time cycle during which signal indications do not change.

Interval Sequence. The order of appearance of signal indications during successive intervals of a time cycle.

Luminaire. The assembly which houses the light source and controls the light emitted from the light source. Luminaires consist of hood (including socket), reflector, glass globe or refractor, and ballast.

Lighting Standard. The pole and mast arm which support the luminaire.

Major Street. The roadway approach or approaches at an intersection normally carrying the major volume of vehicular traffic.

Manual Operation. The operation of a signal controller by means of a hand-operated switch.

Minimum Period. In semi-traffic-actuated controllers, the shortest time for which the right of way shall be given to the approaches not having detectors.

Minor Street. The roadway approach or approaches at an intersection normally carrying the minor volume of vehicular traffic.

Passage Period. The time allowed for a vehicle to travel at a selected speed from the detector to the nearest point of conflicting traffic.

Pedestrian Phase. A traffic phase allocated to pedestrian traffic which may provide a right of way pedestrian indication either concurrently with one (1) or more vehicular phases, or to the exclusion of all vehicular phases.

Preemption. The transfer of normal control of signals to a special signal control mode.

Pretimed Controller Unit. An automatic control device for supervising the operation of traffic control signals in accordance with a pretimed cycle and divisions thereof.

Recall Switch. A manual switch in a traffic-actuated controller which will cause the automatic return of the right of way to a street regardless of the absence of actuation on that street.

Rest. The interval portion of a phase when present timing requirements have been completed.

Right of Way. The privilege of the immediate use of the highway.

Signal Face. That part of a signal head provided for controlling traffic in a single direction and consisting of one (1) or more lenses. Turning indications may be included in a signal face.

Signal Head. An assembly containing one (1) or more signal faces.

Signal Indication. The illumination of a traffic signal lens or equivalent device, or of a combination of several lenses or equivalent devices at the same time.

Split. A division of the cycle length allocated to each of the various phases (normally expressed in percent).

Time Cycle. The number of seconds required for one (1) complete revolution of the timing dial or complete sequence of signal indications.

Traffic-Actuated Controller Unit. A controller assembly for supervising the operation of traffic control signals in accordance with the varying demands of traffic as registered with the controller by detectors.

Traffic Phase (Traffic Movement). Those right of way and clearance intervals in a cycle assigned to any independent movement(s) of traffic.

Unit Extension. The minimum time, during the extendable portion, for which the right of way must remain on any traffic phase following an actuation on that phase, but subject to the extension limit.

Vehicle. Any motor vehicle normally licensed for highway use by the State of Nevada.

Visor (Hood). That part of a signal section which protects the lens face from direct ambient light.

MATERIALS AND INSTALLATION

623.02.01 General. Where existing systems are to be modified, the existing materials shall be incorporated in the revised system, salvaged, or abandoned as specified.

623.02.02 Foundations. Foundations for posts, standards, pedestals, and controller bases shall be Class A or Class AA Portland cement concrete. Portland cement concrete shall conform to the provisions in Section 501, "Portland Cement Concrete."

Foundations shall be placed "in the solid" and monolithic where practicable. For posts, standards, and pedestals not on structures, the top two (2) inches of the concrete foundation shall be placed after the post, standard, or pedestal is in proper position. The exposed portions of the foundation shall be formed to present a neat appearance.

After each post, standard, or pedestal on structures is in proper position, grout shall be placed under the base plate. The exposed portions shall be formed to present a neat appearance. Grout shall consist of one (1) part by volume of Portland cement and three (3) parts of clean sand, shall contain only sufficient moisture to permit packing, and shall be cured by keeping it damp for three (3) days.

Forms shall be true to line and grade. Tops of foundations for posts and standards, except special foundations, shall be finished to curb or sidewalk grade or as directed by the Engineer. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in proper position and proper height, and shall be held in place by means of a template until the concrete sets.

Anchor bolts, anchor bars, or studs and nuts shall conform to the specifications of ASTM Designation A307 and shall be provided with two (2) nuts and two (2) washers each. Anchor bolts, nuts, and washers shall be galvanized in accordance with the requirements of ASTM Designation A153.

Plumbing of standards shall be accomplished by adjusting nuts before grouting or before the foundation is finished to final grade. Shims or other similar devices for plumbing or raking of posts, standards, or pedestals will not be permitted.

Both forms and ground which will be in contact with the concrete shall be

thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

Ordinary surface finish, as specified in subsection 502.03.18, "Ordinary Surface Finish," shall be applied to exposed surfaces of concrete.

Where obstructions prevent the construction of a planned foundation, the Contractor shall construct an effective foundation satisfactory to the Engineer.

The foundation shown on the plans shall be extended if conditions require additional depth, and such additional work, if ordered by the Engineer, will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Unless otherwise shown on the plans, all standards to be relocated shall be provided with new foundations and anchor bolts of the proper type and size.

Posts, poles, standards, and pedestals, except concrete pedestals cast in place, shall not be erected until the foundation has set at least seventy-two (72) hours, and shall be plumbed or raked, as directed by the Engineer.

In unpaved areas, a raised pad of Portland cement concrete of the size shown on the plans shall be placed in front of each controller cabinet.

When a foundation is to be abandoned in place, the top of foundation, anchor bolts, and conduits shall be removed to a depth of five-tenths (0.5) foot below surface of sidewalk or unimproved ground. The resulting hole shall be backfilled with material equivalent to the surrounding material.

623.02.02A Excavating and Backfilling. The excavations required for the installation of conduit, foundations, and other appurtenances shall be performed in such a manner as to avoid any unnecessary damage to street, sidewalks, landscaping, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appurtenances and foundations. Excavation shall not be performed until immediately before installation of conduit and other appurtenances. The material from the excavation shall be placed in a position that will not cause damage or obstruction to vehicular and pedestrian traffic nor interfere with surface drainage.

Unless otherwise permitted in writing by the Engineer, all surplus excavated material shall be removed and disposed of within forty-eight (48) hours outside the highway right of way in accordance with the provisions in subsection 107.14, "Disposal of Material Outside the Highway Right of Way."

The excavations shall be backfilled in conformance with the provisions in Section 207, "Backfill."

Excavations after backfilling shall be kept well filled and maintained in a smooth and well-drained condition until permanent repairs are made.

All excavations shall be filled, and sidewalks, pavement, and landscaping restored at each intersection prior to excavating at any other intersection, unless otherwise permitted by the Engineer.

Excavations in the street or highway shall be performed in such a manner that not more than one (1) traffic lane is restricted in either direction at any time.

623.02.03 Removing and Replacing Improvements. Improvements such as sidewalks, curbs, gutters, Portland cement concrete and asphalt

concrete pavement, base material, lawns, and plants, and any other improvements removed, broken, or damaged by the Contractor's operations, shall be replaced or reconstructed with the same kind of material as found on the work or with materials of equal quality. The new work shall be left in a serviceable condition satisfactory to the Engineer.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed as above specified.

The outline of all areas to be removed in Portland cement concrete sidewalks and driveways and in pavements shall be cut to a minimum depth of one and one-half (1½) inches with an abrasive type saw prior to removing the sidewalk, driveways, and pavement material. The cut for the remainder of the required depth may be made by a method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

623.02.04 Standards, Steel Pedestals, and Posts. Standards for traffic signals and highway lighting and steel pedestals for cabinets and other similar equipment shall be located as shown on the plans. Workmanship and finish shall be equal to the best general practice of metal fabrication shops. All welding shall conform to AWS D2.0, "Specifications for Welded Highway and Railway Bridges," and to the requirements in this section.

Type 1–A and Type 1–B standards shall be used for post-top mounting of traffic signals with or without bracket mounted signals as shown on the plans.

Type 5, Type 10, Type 30, Type 40, and Type 49 standards shall be used for mast arm mounting of traffic signals without luminaires and with or without bracket mounted traffic signals.

Type 6, Type 20, Type 28, Type 35, Type 42, Type 44, Type 45, and Type 50 standards shall be used for mast arm mounting of both luminaires and traffic signals and with or without bracket mounted traffic signals.

Type 7, Type 14, and Type 16 standards shall be used for mast arm mounting of luminaires with or without bracket mounted traffic signals.

Type 1–A and Type 1–B standards and steel pedestals for controller cabinets shall be constructed of No. 11 or heavier U.S. Standard Gage steel or four (4) inch standard pipe or conduit, with the top designed for post-top slipfitter.

Standard pipe shall conform to the specifications of ASTM Designations A53 or A120.

All ferrous metal parts of standards, fifteen (15) feet and longer, shall conform to the details shown on the plans and the following requirements:

Standards shall be fabricated from (a) sheet steel conforming to the specifications of ASTM Designation A611, Grade C or ASTM Designation A570, Grade C, or from (b) sheet steel of weldable grade. If alternative (b) is used, the steel, after fabrication, shall have a minimum yield of forty-eight thousand (48,000) pounds per square inch.

Standards with luminaire arms only shall be fabricated of not less than No. 10 U.S. Standard Gage steel, except that when material conforming to alternative (b) above is used, the gage shall not be less than No. 11 U.S. Standard Gage steel.

Standards may be fabricated of full length sheets or shorter sections. Each section shall be fabricated from not more than two (2) pieces of sheet steel. Where two (2) pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt-welded together, the welded seams on adjacent sections shall be placed to form continuous straight seams from base to top of standard.

Standards shall be straight, with a permissive variation not to exceed one (1) inch measured at the midpoint of a twenty-eight and five-tenths (28.5), thirty (30), or thirty-five (35) foot standard and not to exceed three-fourths (3/4) inch measured at the midpoint of an eighteen (18), twenty (20), or twenty-five (25) foot standard.

Mast arms for all standards, other than Types 2, 3, and 4 standards, shall be fabricated from material as specified for standards and shall conform to the dimensions shown on the plans.

Tie rods for mast arms for Types 2, 3, and 4 standards shall be manufactured of structural steel and pipe as shown on the plans. Structural steel shall conform to the specifications of ASTM Designation A36. Tie rods shall be provided with two (2) nuts and two (2) lock washers at each end. Tie rods shall be installed with no kinks or bends.

The butt-welded transverse joints shall be strengthened by inserting a metal sleeve at each joint. The sleeve shall be No. 10 U.S. Standard Gage steel and made from steel having the same chemical composition as the steel in the standard. The metal sleeve shall have a minimum length of one (1) inch. The sleeve shall be centered at the joint and have the same taper as the standard with the outside of the sleeve in full contact with the inside of the standard throughout the sleeve length and circumference.

All welds shall be continuous.

The weld metal at the transverse joint shall extend to the sleeve, making the sleeve an integral part of the joint.

All longitudinal welds shall be performed by the submerged arc process.

All exposed welds, except fillet welds, shall be ground flush with the base metal.

All exposed edges of the plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to one-eighth (1/8) inch radius, unless otherwise shown on the plans. Shafts shall be provided with slip-fitter shaft caps.

Handholes in the base of standards shall conform to the details shown on the plans.

Push button posts and guard posts shall be pipe conforming to the specifications of ASTM Designations A53 or A120.

Holes left in the shafts of existing standards, due to removal of equipment or mast arms, shall be repaired by welding in a suitable disk, grinding smooth, and painting as provided for repairing damaged galvanized surfaces in Section 715, "Galvanizing."

When directed by the Engineer, existing standards to be relocated or reused in place shall be repaired prior to repainting or regalvanizing. Large dents shall be removed, shafts shall be straightened, and portions which are in poor condition due to corrosion or damage shall be replaced. Extent of repairs of replacements will be determined by the Engineer and said repairs or replace-

ments ordered by the Engineer will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Anchor bolts and nuts required for relocating existing standards shall be furnished by the Contractor.

New standards, posts, and other ferrous materials shall be galvanized as provided in subsection 623.02.15, "Galvanizing."

623.02.05 Conduit. All conductors shall be run in conduit, except for overhead and temporary installations and where conductors are run inside poles.

Conduit shall be of the sizes shown on the plans, as specified in this subsection or in the special provisions. In addition, the Contractor may, at his option and expense, use conduit of a larger size than that shown or specified provided the larger size is used for the entire length of the run from outlet to outlet. Reducing couplings will not be permitted.

(a) Material. Conduit and fittings shall be the rigid metal type manufactured of mild steel conforming to UL Publication UL 6 for Rigid Metallic Conduit or, at the option of the Contractor, conduit to be installed underground may be rigid nonmetallic type conforming to the requirements of the UL Standard for Rigid Nonmetallic Conduit (Publication UL 651).

A Certificate of Compliance conforming to the provisions in subsection 106.05, "Certificates of Compliance," shall be submitted by the manufacturer with all rigid metallic conduit and all rigid nonmetallic conduit.

Where rigid metallic conduit is used underground, it shall be either tarred and wrapped or shall be spirally wrapped with a corrosion protective polyvinyl chloride or polyethylene pressure sensitive tape, applied with a suitable primer. The wrap shall have a nominal thickness of twenty (20) mils, consisting of either one (1) layer of twenty (20) mil tape or two (2) separate layers of ten (10) mil tape. A single wrap of ten (10) mil tape with a half lap will not be acceptable.

(b) Use. Conduit to be installed on the surface of poles or structures or other exposed locations shall be the rigid metal type and shall be unpainted, except that exposed conduit installed on a painted structure shall be painted the same color as the structure.

Where nonmetallic conduit is to be installed, the conduit run between the pole base and the nearest pull box and the conduit in structures may be of the nonmetallic type.

Where existing rigid metal conduit systems are to be modified or extended, rigid metal conduit only shall be installed.

Where a pull box is installed adjacent to the base of an electrolier, conduit installed from the pull box to the standard shall not be less than one and one-half (1½) inches in diameter.

Where pull boxes are installed adjacent to the base of a signal standard or controller pedestal, conduit installed between pull boxes and the standard or pedestal shall not be less than two (2) inches in diameter, unless otherwise shown on the plans.

Conduit for detector runs shall be not less than one (1) inch in diameter. All conduit not otherwise specified shall be one and one-half (1½) inch in diameter.

Conduit running from a pull box to soffit, wall, or other lights or fixtures below the grade of the pull box shall be installed in the end of the pull box with the centerline of the conduit terminus a minimum of five (5) inches above the bottom of the pull box.

On conduit runs that contain signal cable exceeding fifty (50) feet in length, PVC factory coated rigid metallic bends shall be used. On conduit runs fifty (50) feet or less, the Contractor may use PVC factory coated rigid metallic bends or PVC Schedule 40 conduit bends.

(c) Installation. Conduit shall be installed in conformance with the codes and regulations listed in subsection 623.01.02, "Regulations and Code."

Conduit runs shown on the plans may be changed to avoid underground obstructions with written approval by the Engineer.

The ends of all conduits, whether shop or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made square and true so that the ends will butt or come together for the full circumference thereof. Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used for coupling metal type conduit, an approved threaded union coupling shall be used. The threads on all ferrous metal conduit shall be painted with rust preventive paint before couplings are made up. All couplings for metal type conduit shall be tightened until the ends of the conduits are brought together, providing a good electrical connection throughout the entire length of the conduit run. Where the coating on metal conduit has been damaged in handling or installing, such damaged places shall be painted with rust preventive paint. Nonmetallic type conduit shall be cut with a hacksaw or other approved tool. Nonmetallic type conduit connections shall be of the solvent weld type. Exposed ungalvanized threads on metal conduit resulting from field cuts shall be painted with rust preventive paint.

All metal type conduit ends shall be threaded and shall be capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with conduit bushings. Nonmetallic type conduit ends shall be capped until wiring is started.

Nonmetallic conduit fittings for connecting nonmetallic conduit to rigid metal conduit shall be threaded on the metal conduit side.

Conduit bends, except factory bends, shall have a radius of not less than six (6) times the inside diameter of the conduit. Where factory bends are not used, conduit shall be bent, without crimping or flattening, using the longest radius practicable.

A nylon pull string shall be installed in all conduits which are to receive future conductors. At least five (5) feet of pull string slack shall be coiled up at each termination.

Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel or cylindrical wire brush and blown out with compressed air.

Conduit shall be laid to a depth of not less than eighteen (18) inches below the curb grade in sidewalk areas and curbed paved median areas, twenty-four (24) inches below highway pavement grade in road areas and finished grade in all other areas, except that conduit may be laid on top of the existing pavement within new curbed medians being constructed on top of said pavement.

Conduit runs parallel to curbs shall be placed adjacent to back of curb, except where in conflict with existing facilities.

Conduit stubs from electrolier bases shall extend at least six (6) inches from face of foundation and at least eighteen (18) inches below top of foundation.

Rigid metal conduit shall be placed under existing pavement by approved jacking or drilling methods. Pavement shall not be disturbed without permission from the Engineer. In the event obstructions are encountered, upon approval of the Engineer, small test holes may be cut in the pavement to locate obstructions. Jacking or drilling pits shall be kept two (2) feet clear of the edge of any type of pavement wherever possible. Excessive use of water, such that pavement might be undermined, or subgrade softened, will not be permitted.

Rigid nonmetallic type conduit shall not be used for drilling or jacking. Installation of rigid nonmetallic type conduit under existing pavement will be permitted if a hole larger than the conduit is predrilled and the conduit installed by hand. Bottom of trenches for rigid nonmetallic conduit shall be relatively free of sharp irregularities which would cause pinching and excessive bending of the conduit. The trench shall be excavated to four (4) inches below the invert grade of the conduit and backfilled with a granular material with one hundred (100) percent passing the three-eighths (3/8) inch size sieve except where backfilled with concrete. A cradle shall be shaped in the granular material cushion to support the conduit. The first six (6) inches of backfill over the top of the conduit shall be of this granular material. The top six (6) inches shall be backfilled and compacted as shown on the plans or as directed by the Engineer.

Conduit to be placed beneath railroad tracks shall comply with the following:

The conduit shall be rigid metal type, one and one-half (1 1/2) inch minimum size and shall be placed to a minimum depth of three (3) feet below bottom of tie. The near side of each conduit jacking pit shall be constructed not less than twelve (12) feet from the centerline of track. When the jacking pit is to be left overnight it shall be covered with substantial planking.

Conduit terminating in standards or pedestals shall extend not more than two (2) inches vertically above the foundation and shall be sloped towards the handhold opening. Conduit entering through the side of nonmetallic pull boxes shall terminate not more than two (2) inches inside the box wall and not less than two (2) inches above the bottom, and shall be sloped toward top of box to facilitate pulling of conductors. Conduit entering through the bottom of a pull box shall terminate one (1) to two (2) inches above the bottom and shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduits shall enter from the direction of the run.

Conduit for future use in structures shall be threaded and capped. Conduit leading to soffit, wall, or other lights or fixtures below the grade of the pull box shall be sealed by means of a sealing fitting and sealing compound, except that sealing fitting and sealing compound will not be required where conduit terminates in a structural pull box.

Conduits in bridge superstructures shall be supported as shown on the plans, in conformance with the following:

Steel hangers, steel brackets, and other fittings shall conform to the provisions in Section 712, "Miscellaneous Metal."

Cast-in-place metal inserts for hangers or brackets shall be capable of developing twenty thousand (20,000) pounds per square inch in tension on the net section of the bolt or threaded rod.

Openings for conduits through bridge superstructure concrete shall be formed or may consist of pipe sleeves.

Where conduits pass through the abutment concrete, the conduits shall be wrapped with two (2) layers of ten (10) pound asphalt-felt building paper, securely taped or wired in place.

The space around conduits through bridge abutment walls shall be filled with Portland cement mortar conforming to the provisions in subsection 706.03.04, "Mortar," except that the proportion of cement to sand shall be one (1) to three (3).

When the bridge superstructure is to be prestressed the space around conduits through abutments shall not be filled until the prestressing has been completed.

Conduit run on the surface of structures shall be secured with galvanized malleable iron clamps spaced not more than five (5) feet apart.

Attention is directed to subsection 623.02.10, "Bonding and Grounding." Where pull boxes are placed in conduit runs, the conduit shall be fitted with threaded bushings and bonded.

The location of ends of all conduits in structures, or terminating at curbs, shall be marked by a "Y" at least three (3) inches high cut into the face of curb, gutter, or wall, directly above the conduit and above grade line.

623.02.06 Pull Boxes. Pull boxes shall be installed at the locations shown on the plans.

Plastic and concrete pull boxes placed in the roadway or containing interconnect cable and located outside of sidewalk sections shall have steel covers fitting over entire pull box. All concrete boxes not requiring steel covers shall have cast iron lids. Plastic pull boxes not requiring steel covers may have approved plastic lids.

(a) Materials. Pull boxes, covers, and extensions for installation in the ground or in sidewalk areas shall be of the sizes and details shown on the plans and shall be precast reinforced concrete, except that alternative materials and designs may be used if units of equal strength, without excessive deflection, will be provided. Material shall be self-extinguishing when tested in accordance with ASTM Designation D635, and shall show no appreciable change in physical properties with exposure to the weather. Where a ballast or transformer is to be placed in a nonmetallic pull box, the box shall be provided with recesses for a hanger as shown on the plans.

Plastic pull boxes shall be of sufficient rigidity that when a designated concentrated force is applied perpendicularly to the midpoint of one (1) of the long sides at the top while the opposite long side is supported by a rigid surface, it shall be possible to remove the cover without the use of tools. The designated concentrated force shall be one hundred fifty (150) pounds for a

No. 3½ pull box and shall be one hundred (100) pounds for a No. 5 or No. 7 pull box.

When a vertical force of one thousand five hundred (1,500) pounds is applied, through a one-half (½) inch by three (3) inch by six (6) inch steel plate, to a plastic cover in place on a pull box, the cover shall not fail and shall not deflect more than one-fourth (¼) inch. The steel plate shall be centered on the cover with its longitudinal axis coinciding with the longitudinal axis of the cover.

Pull boxes and covers for installation in structures shall be of the sizes and details shown on the plans. In lieu of the structure pull box shown on the plans, the Contractor may use a telescoping steel pull box, with interior dimensions, conduit entrances, and cast iron cover conforming to the details shown on the plans. Design of the steel pull box shall be submitted to the Engineer for review prior to fabrication.

Covers shall be secured with three-eighths (⅜) inch bolts, capscrews, or studs, and nuts which shall be of brass, stainless steel, or other noncorroding material. Stainless steel hold-down bolts, capscrews, or studs, and nuts and washers shall have a chromium content of not less than eighteen (18) percent and a nickel content of not less than eight (8) percent. Nuts shall be recessed below surface of cover.

Junction boxes for installation in structures shall conform to the details shown on the plans.

Junction boxes which are to be placed in concrete barrier rails, as indicated on the plans, shall have covers installed in a manner that will result in the cover conforming to the contours of, and flush with the exterior of the barrier rail.

All ferrous metal parts shall be galvanized in accordance with the provisions in subsection 623.02.15, "Galvanizing."

(b) Cover Marking. Covers for pull boxes shall be marked as follows:

1. "Traffic Signal." Where pull box contains traffic signal conductors with or without street lighting conductors.

2. "Street Lighting." Where pull box contains street lighting conductors only. "High Voltage" shall be inscribed below where street lighting voltage is above six hundred (600) volts.

3. "Communication." For pull boxes where communication conduit enters the pull box.

4. "Sprinkler Control." For pull boxes where sprinkler control conduit enters the pull box.

5. "Count Station." For pull boxes where traffic count station conduit enters the pull box.

6. "Ramp Meter." For pull boxes where ramp metering conduit enters the pull box.

Marking shall be clearly defined and uniform in depth and may be placed parallel to either the long or short sides of the cover.

Marking letters shall be between one (1) and three (3) inches high.

Marking shall be applied to each steel or cast iron cover prior to galvanizing by one (1) of the following methods:

a. Cast iron strips, at least one-fourth (¼) inch thick, with the letter raised a minimum of one-sixteenth (1/16) inch. Strips shall be fastened to

covers with one-fourth (1/4) inch flathead stainless steel machine bolts and nuts. Bolts shall be peened after tightening.

b. Sheet steel strips, at least twenty-two (22) gage with the letters raised a minimum of one-sixteenth (1/16) inch above the surrounding surface of the strips. Strips shall be fastened to covers by spot welding, tack welding, or brazing, or with one-fourth (1/4) inch roundhead stainless steel machine bolts and nuts. Bolts shall be peened after tightening.

c. Bead welding the letters on the covers. The letters shall be raised at least three thirty-seconds (3/32) inch.

(c) Installation and Use. Pull boxes shall be installed at the locations shown on the plans or, in long runs, they shall be spaced at not over two hundred (200) foot intervals. The Contractor may, at his expense, install additional pull boxes to facilitate his work.

The tops of pull boxes installed in the ground or in a sidewalk area shall be flush with the surrounding grade or top of adjacent curb. Where practical, pull boxes shown in the vicinity of curbs shall be placed adjacent to the back of curb, and pull boxes adjacent to standards shall be placed along the side of foundations as shown on the plans.

The bottoms of pull boxes installed in the ground or in sidewalk areas shall be bedded in crushed rock as shown on the plans and shall be grouted prior to the installation of conductors. A layer of roofing paper shall be placed between the grout and the crushed rock sump. A one (1) inch drain hole shall be provided in the center of the pull box through the grout and the roofing paper.

623.02.07 Expansion Fittings. Expansion fittings, as detailed on the plans, shall be installed where the conduit crosses an expansion joint in the structure. Each expansion fitting shall be provided with a copper bonding jumper having the ampacity required by the Code.

Expansion-deflection fittings shall consist of a molded neoprene sleeve with a bonding jumper passing through a separate waterproof compartment and two (2) silicon bronze couplings. Fittings shall permit a minimum of three-fourths (3/4) inch expansion and contraction and a three-fourths (3/4) inch deflection without deformation.

623.02.08 Conductors. Conductors shall consist of solid or stranded copper of the gage shown on the plans unless specified otherwise.

Copper wire shall conform to the specifications of ASTM Designations B3 and B8.

(a) Traffic Signal and Multiple Lighting Conductors. Conductors for traffic signal, flashing beacon, and multiple lighting installations shall be UL listed and rated for six hundred (600) volt operation. The insulation for No. 16 or smaller conductors shall be Type TF. The insulation for No. 14 and larger conductors shall be one (1) of the following:

1. Type TW polyvinyl chloride conforming to the requirements of ASTM Designation D2219.
2. Type THW polyvinyl chloride.
3. Type XHHW or Type RHW cross-linked polyethylene.

Minimum thickness of any of the above insulations shall be forty-five (45)

mils for conductor sized No. 14 to No. 10, inclusive, and sixty (60) mils for No. 8 to No. 2, inclusive.

Within steel poles and arms only, insulation for No. 10, 12, and 14 conductors may be Type UF, sixty (60) mils.

All conductors used in controller cabinet wiring shall be No. 22 AWG or larger. Conductors smaller than No. 14 AWG shall conform to Military Specification MIL–W–16878D, Type B, Vinyl-Nylon Jacket, six hundred (600) volt, one hundred fifteen (115) degrees Centigrade. Conductors No. 14 AWG and larger shall be as specified above.

All conductors in controller cabinets subject to flexing during opening and closing of the cabinet door or on removal of equipment from the cabinet shall be stranded. Conductors No. 14 AWG through No. 10 AWG, inclusive, shall be nineteen (19) strand and conductors No. 16 AWG shall be twenty-six (26) strand.

Conductors in traffic actuated controller cabinets between service terminals and "AC+" terminals on external light relays (including connections to the police panel switches), the signal light neutral and all conductors in the highway lighting circuit within the controller cabinet shall be No. 10 AWG or larger. All other conductors in the signal light circuits shall be No. 14 AWG.

Conductors in pretimed controller cabinets between the service terminals and "AC+" common bus to signal light circuits (including switches, radio interference suppressor, flasher relays, and harness conductors to the controller) shall have an ampacity of twenty (20) amperes at one hundred sixty (160) degrees Fahrenheit.

Conductors for wiring flush wall luminaires shall be Type SA stranded copper, insulated with silicone rubber and asbestos braid for use at temperatures up to one hundred twenty-five (125) degrees Centigrade.

Overhead lighting conductors shall be No. 8 AWG or larger medium hard drawn copper with weatherproof covering.

Vehicle detector conductors and lead-in cable are specified in subsection 623.02.37, "Vehicle Detectors."

(b) Traffic Signal Cable. Individual signal cable shall be installed between the controller cabinet and the terminal block in the pole mounted signal head for each mast arm signal pole. Individual signal conductors shall only be used between the terminal block and each signal head and to poles without mast arms. Cable shall conform to IMSA Specification No. 20–1 and shall be sized as indicated on the plans.

Interconnect cable shall be REA Specification PE 39 unless otherwise noted on the plans.

Opticom detector cable shall be three (3) conductor, No. 20 cable and shall be either 3M Model 138 or Belden No. 8723 types.

(c) Conductor Identification. All signal conductors and cables shall have clear, distinctive and permanent markings on the outer surface throughout the entire length showing the manufacturer's name or trademark, insulation type-letter designation, conductor size, voltage rating, and the number of conductors if a cable.

Conductor insulation shall be of a solid color or of basic colors with a permanent continuous colored identification stripe as detailed in the "Conductor Table" unless otherwise specified.

CONDUCTOR TABLE

Circuit	Signal Phase or Function	Identification: Insulation Colors: Base	Identification: Insulation Colors: Stripe (Note 1)	Identification: Band Symbols (Note 6)	Size (AWG)
Vehicle Signals	A	Red, Yellow, Green	Black	Band only special (A_1) and overlap (A_1+C_1) phases. Simple phases such as A, B, C, or D do not require banding	14
	B	Red, Yellow, Green	White		14
	C	Red, Yellow, Green	None		14
	D	Red, Yellow, Green	Orange		14
Pedestrian Signals	Aw	Red, Green	Black	Aw	14
	Bw	Red, Green	White	Bw (Note 2)	14
	Cw	Red, Green	None	Cw	14
	Dw	Red, Green	Orange	Dw	14
Pedestrian Push Buttons	Aw	Blue	Black	P-A	14 or larger
	Bw	Blue	White	P-B	
	Cw	Blue	None	P-C (Note 2)	
	Dw	Blue	Orange	P-D	
Traffic Signal Controller	Ungrounded between Service Switch and Controller	Black	None	CON	10 or larger
Lighting	Pull box to Luminaire	Black	None	No band required	14
Multiple Highway Lighting (Note 9)	Ungrounded—Line 1	Black	None	ML 1	10 or larger
	Ungrounded—Line 2	Red	None	ML 2	
Lighting Control	Ungrounded to P.E.C. unit	Black	None	C-1	14
	Switching leg from P.E.C. unit or SM transformer	Red	None	C-2	14
Multiple Service	Ungrounded—Line 1 (Signals)	Black	None	No band required except per Note 5	8 or larger
	Ungrounded—Line 2 (Lighting)	Red	None		
Sign Lighting (Note 8)	Ungrounded between transformer Service Switch and Ballasts	Black	None	SL	12 or larger

(Continued Page 488)

CONDUCTOR TABLE—*Continued*

Circuit	Signal Phase or Function	Identification: Insulation Colors: Base	Identification: Insulation Colors: Stripe (Note 1)	Identification: Band Symbols (Note 6)	Size (AWG)
Flashing Beacons (Note 7)	Ungrounded between flasher and beacons	Red or Yellow	None	F-Location No. See Note 3	14 or larger
Neutral and Common (Note 4)	Detectors and Pedestrian Push Buttons	White	Black	No band required	12 or 14
	Signals and Multiple Lighting	White	None	No band required	10 or larger
	Flashing Beacons and Sign Lighting	White	None	No band required	12
	Lighting Control	White	None	C–3	14
	Multiple Service	White	None	No band required	8 or larger
	Common	White	None	I	14
Railroad Pre-emption		Black	None	R	14
Spares		Black	None	No band required	14

NOTES

1. On overlaps, insulation is striped for first phase in designation, for example, a phase (A1+C1) conductor is striped as for phase A.
2. Stamp for overlap and special phases as required.
3. Flashing beacons having separate service do not require banding.
4. A single No. 12 common shall be used for pressure sensitive detectors and pedestrian push buttons. A single No. 14 AWG common shall be used when only pedestrian push buttons are connected.
5. "S" if circuit is switched on line side of service equipment by utility.
6. Band conductors in each pull box and near ends of termination points. On signal light circuits, a single band shall be placed around two (2) or three (3) ungrounded conductors comprising a phase.
7. Ungrounded conductors between service switch and flasher mechanism shall be black and stamped as indicated in this column.
8. Conductors between ballasts and sign lighting lamps shall be No. 16 and color shall correspond to that of the ballast leads.
9. Both conductors between ballast and lamp shall be black.
10. Conductors for inductive loop detectors are specified in subsection 623.02.37 "Vehicle Detectors."

623.02.09 Wiring. Wiring shall be done in conformance with the regulations and code listed in subsection 623.01.02, "Regulations and Code," and the following additional requirements:

(a) Circuitry. Sufficient signal light conductors shall be provided to perform the functional operation of the signal system and, in addition thereto, three (3) spare conductors of a size equal to the largest signal light conductor in the run, except neutral, shall be provided throughout the signal light system, unless shown otherwise on the plans.

All signal light conductors, except branch neutrals, shall be run continuously without splices from a terminal block located in a cabinet, compartment, or signal head, to a similarly located terminal block. Signal light conductors shall not run to a terminal block on a standard unless they are to be connected to a signal head that is mounted thereon.

Connection to each terminal of a pedestrian push button shall be by a single conductor.

The neutral for pedestrian push button circuits shall be separate from the signal light circuit neutral.

(b) Installation. Powdered soapstone, talc, or other UL approved inert lubricant shall be used in placing conductors in conduit.

Conductors shall be pulled into conduit by hand and the use of winches or other power actuated pulling equipment will not be permitted.

When new conductors are to be added to existing conductors in a conduit, all conductors shall be removed; the conduit shall be cleaned as provided in subsection 623.02.05C, "Installation;" and both old and new conductors shall be pulled into the conduit as a unit.

Where signal conductors or cable are run in lighting standards containing high-voltage series street lighting conductors, either the signal conductors or the lighting conductors shall be encased in flexible or rigid metal conduit, to a point where the two (2) types of conductors are no longer in the same raceway. Where telephone circuits are installed adjacent to signal and lighting circuits, the telephone conductors shall be encased in UL approved flexible metal conduit.

Temporary conductors less than ten (10) feet above grade shall be enclosed in flexible or rigid metal conduit.

At least one (1) foot of slack shall be left for each conductor at each signal or lighting standard, or combined standard, and at least three (3) feet of slack at each pull box.

At least three (3) feet of slack shall be left for each conductor at each splice.

Ends of spare conductors shall be taped.

Conductors within fixtures or cabinets shall be cabled together with self-clinching nylon cable ties, waxed lacing, or other method permitted by the Engineer.

Wiring within controller cabinets shall be neatly arranged and laced, or enclosed in plastic tubing or raceway.

Small permanent identification bands shall be marked as detailed in the conductor table following subsection 623.02.08, "Conductors." The band

shall be securely attached to each conductor in each pull box and near the end of each conductor where conductors are terminated. Where circuit and phase are clearly indicated by conductor insulation, bands need not be used. Permanent identification bands shall be embossed aluminum foil tape with pressure-sensitive, oil resistant backing. Tape shall be of a type such that embossed symbols contrast with the background color.

(c) Connectors and Terminals. Conductors shall be joined by the use of connectors or other methods permitted by the Engineer. All splices, with or without connectors, shall be soldered by the pouring or dipping method, except that soldering of pressure connectors and terminals may be omitted provided the connectors and terminals are applied with the proper type tool as recommended by the manufacturer of the connector or terminal being applied. Finished connections and terminals shall comply with the requirements of Military Specification MIL–T–7928.

All stranded conductors smaller than No. 14 AWG shall be terminated in crimp style terminal lugs.

(d) Splicing. Unless specified otherwise or permitted by the Engineer, splices will be permitted only in the following types of circuits at the following locations:

1. Branch signal light neutrals in pull boxes.
2. Pedestrian push button circuits in pull boxes.
3. Multiple lighting conductors in bases of standards or in pull boxes.
4. In pull boxes in series lighting circuits where runs are more than four hundred (400) feet between units.
5. In modified traffic signal systems where shown on the plans.

In lieu of the six hundred (600) volt or the five thousand (5,000) volt splice and splice insulation shown on the plans, the Contractor may elect to use:

A pin and receptacle, locking type connector, with waterproof housing, capable of being disconnected without damage. The pin shall be of medium hard copper material with the portion to be crimped onto the conductor fully annealed. The receptacle shall be of copper material fully annealed. The pin and receptacle shall be of a size to provide not less than ninety (90) percent ampacity of the conductor being spliced. The pin and receptacle shall be applied to the conductor using a tool as recommended by the connector manufacturer and soldering will not be required. Both the pin and receptacle shall have centrally located, recessed locking areas, which shall match complementary areas of the housing.

The receptacle shall establish contact pressure with the pin through the use of a copper beryllium sleeve spring and the receptacle and pin shall lock together so that the connection will be maintained when a minimum force of twenty (20) pounds tension pull is applied to the attached conductors.

Separate housings shall be provided for the pin and the receptacle. Each housing shall be made of water resisting synthetic rubber suitable for direct burial in the ground or installation in direct sunlight. Each housing shall have an interior arrangement, complementary to the pin and receptacle, suitable to receive and securely retain the pin and receptacle, also a section to form a water-seal between the housings at the point of disconnection. A small slot or vent shall be provided along the housings to permit the exclusion of air.

Sufficient silicon type insulating compound to fill all the voids in the assembly shall be placed in the housings before installing the pin and receptacle.

In lieu of the six hundred (600) volt splice and splice insulation shown on the plans, the Contractor may elect to use an epoxy insulated spring connector applied as follows:

The ends of the wires shall be joined together with an insulated spring type connector without soldering.

A two (2) component, self-curing, epoxy resin shall be furnished in a double compartment, plastic envelope. The splice insulation shall be made by thoroughly mixing the two (2) components in the envelope and, after cutting open one (1) end of the envelope, inserting the wire-connection into the epoxy resin and then taping shut the open end of the envelope.

Other methods may be used to mix and apply epoxy resin.

Sufficient epoxy resin shall be provided to completely cover the connector and exposed bare wires at connector. The container shall be transparent to allow inspection.

Conductors in controller cabinets, signal cable, and interconnect cable shall not be spliced.

(e) Splice Insulation. Splice insulation shall conform to the details shown on the plans.

Low-voltage type tape shall be UL approved and shall be either of the following types at the option of the Contractor:

1. Self-fusing, oil and flame-resistant, synthetic rubber.
2. Pressure-sensitive, adhesive, polyvinyl chloride, seven one-thousandths (0.007) inch minimum thickness.

Tape for insulating splices in low-voltage circuits (six hundred (600) volts, maximum) by "Method A" as shown on the plans shall be either of the low-voltage types. Splices made by "Method B" on the plans shall be insulated with both types of low-voltage tape.

Tape for insulating splices in high-voltage (over six hundred (600) volts) circuits shall be resistant to ozone, corona, and water. High-voltage tape shall be self-fusing, vegetable oil base, natural rubber.

Where polyvinyl chloride tape is used for a final layer, an electrical insulating coating shall be used which shall be fast drying, resistant to oil, acids, alkalies, and corrosive atmospheric conditions and be compatible with the tape.

Where more than one (1) conductor enters a ballast sleeve, the insulation and taping shall be applied between the conductors in such a manner as to provide a watertight joint. The splice shall be capable of satisfactory operation under continuous submersion in water.

On six hundred (600) volt and five thousand (5,000) volt conductor splices, the Contractor, at his option, may use a cast insulation of self-curing epoxy resin which is compatible with wire insulation to form a moisture resistant joint. The resin shall be resistant to weather and aromatic and straight chain solvents and, in addition, shall not sustain combustion. The resin shall be poured into molds of dimensions suitable for the splice.

On six hundred (600) volt maximum circuits, the Contractor, at his option, may elect to use either of the following splice insulation methods:

a. A minimum of two (2) thicknesses of electrical insulating pad, composed of a laminate of eighty-five one-thousandths (0.085) inch thickness of electrical grade polyvinyl chloride and a one hundred twenty-five one-thousandths (0.125) inch thickness of butyl splicing compound with removable liner. Pads shall be applied to the splice in accordance with the manufacturer's recommendations. The ends of the applied pad shall be wrapped with polyvinyl chloride tape half lapped over the conductor insulation.

b. Heat shrinkable insulating tubing shall be applied after completing the splicing procedure shown on the plans. Insulation over the connector shall consist of a heat shrinkable, mastic lined, heavy wall polyolefin cable sleeve or cover, to which heat shall be applied at a temperature greater than one hundred twenty (120) degrees Centigrade until the sleeve, or cover, shrinks and covers the connector and the mastic material has flowed completely around the cable to form a waterproof insulation.

On five thousand (5,000) volt conductors, the Contractor, at his option, may elect to waterproof splices as follows:

In lieu of the final application of two (2) layers of polyvinyl chloride tape, waterproofing of five thousand (5,000) volt splices after being insulated as shown on the plans shall consist of heat shrinkable, mastic lined, heavy wall polyolefin cable sleeve, or cover, to which heat shall be applied at a temperature greater than one hundred twenty (120) degrees Centigrade until the sleeve, or cover, shrinks and covers the connector and the mastic material has flowed completely around the cable to form a waterproof insulation.

(f) Fused Splice Connectors. In each pull box adjacent to an electrolier or in base of pole, a fused disconnect splice connector shall be installed in each ungrounded conductor between the line and the ballast. The connector shall be readily accessible in the pull box or in the base of the pole.

For two hundred forty (240) volt and four hundred eighty (480) volt circuits, each connector shall be designed so that both ungrounded conductors are disconnected simultaneously. The connector shall have no exposed metal parts.

The splice connector shall completely enclose the fuse and shall protect the fuse against damage from water and weather. The contact between the fuse and fuseholder shall be by spring pressure. Springs shall not be a part of the current carrying circuit. The terminals of the splice connector shall be rigidly crimped, using a tool of the type recommended by the manufacturer of the fused splice connector, on to the line conductors and the conductors to the ballasts and shall be insulated and made waterproof in accordance with the splice connector manufacturer's recommendations.

Fused splice connectors shall not be used in series circuits.

Fuses shall be standard midget, ferrule type.

623.02.10 Bonding and Grounding. Metallic cable sheaths, metal pull box covers, metal conduit, nonmetallic conduit grounding wire, ballast and transformer cases, service equipment, sign switches, anchor bolts, and metal poles and pedestals shall be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire or copper braid of the same cross sectional

area as No. 6 AWG for series lighting systems and No. 8 AWG or larger for all other systems.

Bonding of standards and pedestals shall be by means of a bonding wire or braid attached to the anchor bolts of a three-sixteenths (3/16) inch, or larger, brass or bronze bolt installed in the lower portion of the shaft.

Where slip base standards or slip base inserts are installed, the grounding jumper shall not intrude into the slip plane. Bonding shall be accomplished by a bonding strap to the anchor bolts or a three-sixteenths (3/16) inch or larger brass bolt installed in the bottom slip base plate.

One (1) side of the secondary circuit of series-multiple and step down transformers shall be grounded.

Grounding of metal conduit, service equipment, and neutral conductor at service point shall be accomplished as required by the Code and the serving utility, except that grounding conductors shall be No. 6 AWG or equal.

For bonding purposes in all nonmetallic type conduit, a bare No. 6 AWG copper wire shall be run continuously in circuits used for series lighting, and a bare No. 8 AWG copper wire shall be run continuously in all other circuits. In lieu of the continuous copper ground wire, a ground rod, when approved by the Engineer, may be installed at each pole or standard.

Where nonmetallic conduit is to be installed for future conductors, the above mentioned copper wire may be omitted.

At each multiple service point, unless otherwise shown on the plans, a ground electrode shall be furnished and installed. Ground electrodes of steel or iron shall be one (1) piece lengths of galvanized rod or pipe at least three-fourths (3/4) inch in diameter. Electrodes of nonferrous materials, or their approved equivalent, shall be not less than one-half (1/2) inch in diameter. Ground electrodes shall be installed in accordance with the provisions of the Code. The service equipment shall be bonded to the ground electrode by use of a ground clamp and No. 6 AWG copper wire, enclosed in a one-half (1/2) inch diameter conduit.

When a ground connection is required in a series lighting system, a plug cutout, as shown on the plans, shall be connected into the circuit and installed in a pull box. The plug shall be grounded to a water pipe or ground electrode.

Where a metal conduit system parallels, or crosses, a permanent water system in accessible areas, grounding jumpers shall be installed at intervals not exceeding five hundred (500) feet.

Ground clamps for service grounding and for grounding of equipment on wood poles shall be a one-half (1/2) inch galvanized, malleable iron conduit hub with swivel feature.

On wood poles, all equipment mounted less than eight (8) feet above ground surface shall be grounded.

Bonding of metallic conduit in concrete pull boxes shall be by means of galvanized grounding bushings and bonding jumpers.

Bonding of metallic conduit in steel pull boxes shall be by means of locknuts, one (1) inside and one (1) outside of the box.

623.02.11 Service. Electrical service installation and materials shall conform to the requirements of the serving utility.

Service equipment shall be installed as soon as possible to enable the utility to schedule work well in advance of the completion of the project.

Where the service point is a utility-owned pole, the Contractor shall furnish conduit, conductors, and all other necessary material to complete the installation of the service riser. If the Contractor is required by the plans or special provisions to install the service riser and equipment on a utility-owned pole, the position of the riser and equipment will be determined by the utility.

Upon request of the Contractor, the Engineer will arrange with the serving utility to complete service connections for both temporary and permanent installations and the Contractor shall pay all required costs and fees therefor.

Upon request of the Contractor, the Engineer will arrange for furnishing electrical energy. Energy used prior to completion of the contract will be charged to the Contractor, except that the cost of energy used for public benefit, when such operation is ordered by the Engineer, will be at the expense of the State or local authorities.

Full compensation for furnishing and installing service poles, service equipment, conduit, and conductors (including equipment, conduit, and conductors, placed on utility-owned poles, and the additional conductor where the serving utility requires three (3) wire, one hundred twenty/two hundred forty (120/240) volt service into the meter socket for a one hundred twenty (120) volt load), and for any service connection fees, shall be considered as included in the contract item of electrical work involved and no additional compensation will be allowed therefor.

(a) Service Conduit and Riser. Service conduit for multiple lighting or traffic signals shall be not less than two (2) inches in size. Service conduit for series lighting shall be not less than one and one-half (1 1/2) inches in size.

Service riser conduit shall terminate with a service head or shall be sealed to prevent the entrance of water, as approved by the serving utility.

(b) Service Equipment. Service equipment for multiple lighting systems or traffic signals, or both, shall be a three (3) wire, solid-neutral, fused switch. The switch shall be enclosed in a NEMA Type 3R raintight enclosure which shall be provided with a top hinged cover, hasp for sealing cover, and provisions for locking the handle in the "On" and "Off" positions. The padlock will be furnished by others. Service switch cabinet cover shall not be interlocked with operating handle.

When specified in the special provisions or shown on the plans a circuit breaker may be used in lieu of the service switch specified above. Rating shall be as shown on the plans. Circuit breakers shall be approved and listed by the UL. The operating mechanism shall be enclosed and shall be trip-free from operating handle on overload, shall be trip-indicating, and shall have trip and frame size plainly marked. Multiple-pole circuit breakers shall have a common trip. All circuit breakers shall be quick-make, quick-break on either automatic or manual operation. Contacts shall be silver alloy enclosed in an arc quenching chamber. Overload tripping of breakers shall not be influenced by an ambient temperature range of from zero (0) degrees Fahrenheit to plus one hundred sixty (160) degrees Fahrenheit. Enclosure for circuit breakers shall be provided with a top hinged cover, dead front panel, and a hasp for a padlock.

Where a kilowatt-hour meter is required, a meter socket, as approved by the serving utility, complete with sealings rings, shall be furnished and installed. Service equipment for traffic signals, lighting systems, or flashing beacons shall, in addition, be provided with a manual circuit closing device or space for a test block as required by the serving utility.

Each service for a series lighting circuit shall be provided with a series circuit switch of five thousand (5,000) volt rating. The switch shall be enclosed in a NEMA Type 3R, eighteen (18) inches by twenty-four (24) inches by six (6) inches, cutout box. The cutout box shall be fitted with a cover permanently inscribed "Danger—High Voltage." The cover shall be attached to the box to form a raintight plate and shall require tools for removal. The cutout box shall be installed not less than eight (8) feet above the ground.

Service equipment enclosures, except cast aluminum meter sockets, shall be hot-dip galvanized or, at the option of the Contractor, said enclosures may be provided with a factory applied rust resistant prime coat and baked enamel finish coat in lieu of galvanizing.

623.02.12 Wood Poles. Wood poles for service or temporary installation shall be ASA Class 5, or larger, Douglas Fir or Southern Yellow Pine.

Poles shall not have more than one hundred eighty (180) degrees twist in grain over the full length. Sweep shall be no more than four (4) inches. Top of poles shall be beveled. Poles shall be placed in the ground to a depth of at least six (6) feet. The lengths of poles shall be twenty-five (25) feet for service poles and thirty-five (35) feet for other poles, unless otherwise specified.

After each wood pole is set in the ground, the space around the pole shall be backfilled with selected earth or sand, free of rocks and other deleterious material, placed in layers approximately thirty-three one-hundredths (0.33) foot thick. Each layer shall be moistened and thoroughly compacted.

Mast arms and tie rods for wood pole installations shall conform to the provisions in subsection 623.02.04, "Standards, Steel Pedestals, and Posts," and to the details shown on the plans. Each mast arm shall be provided with an insulated wire inlet and wood pile mounting brackets for mast arm and tie rod crossarm.

Mast arms for luminaires shall be mounted to provide a mounting height of thirty (30) feet. Mast arms for traffic signals, flashing beacons, and overhead detectors shall provide a minimum vertical clearance of seventeen (17) feet from bottom of equipment to the pavement.

Wood poles, not to be painted, shall be pressure treated after fabrication as provided in Section 615, "Preservative Treatment for Timber."

623.02.13 Blank.

623.02.14 Field Tests. Prior to completion of the work, the Contractor shall cause the following tests to be made on all traffic signal, sign illumination, and lighting circuits, in the presence of the Engineer.

(a) Continuity. Each circuit shall be tested for continuity.

(b) Ground. Each circuit shall be tested for grounds.

(c) Megger. A megger test at five hundred (500) volts DC shall be made on each circuit between the circuit and a ground. The insulation resistance shall not be less than ten (10) megohms on all circuits, except for inductive loop detector circuits which shall have an insulation resistance value of not less than one hundred (100) megohms.

(d) Functional. A functional test shall be made in which it is demonstrated that each and every part of the system functions as specified.

The functional test for each new or modified traffic signal, flashing beacon, and ramp metering system shall consist of not less than five (5) days of continuous satisfactory operation. If unsatisfactory performance of the system develops, the condition shall be corrected and the test shall be repeated until the five (5) days of continuous satisfactory operation is obtained.

The initial turn-on shall be made between 9:00 a.m. and 2:00 p.m. unless specified otherwise in the special provisions. Prior to turn-on, all equipment as shown on the plans shall be installed and operable. This includes "WALK—DON'T WALK" pedestrian signals, pedestrian push buttons, vehicle detectors, and highway lighting. All louvers, hoods, and signal heads shall be directed to provide maximum visibility.

Turn-on of new or modified traffic signal systems shall be made only after all traffic signal circuits have been thoroughly tested as specified above and a signal timing program acceptable to the maintenance agency has been implemented.

On all projects with new traffic signal controllers, there shall be a qualified manufacturer's representative present at turn-on to oversee the initial signal system operation.

The functional test for each lighting system and sign illumination system shall consist of an operational test for two (2) consecutive days according to the regular lighting schedule.

During the test period, State and local forces will maintain the system or systems. The cost of any maintenance necessary, except electrical energy and maintenance due to damage by public traffic, shall be at the Contractor's expense and will be deducted from any moneys due, or to become due, the Contractor.

Functional tests shall start on any working day except Friday, or the day preceding a legal holiday.

Shutdown caused by damage by public traffic or a power interruption shall not constitute discontinuity of the functional test.

623.02.15 Galvanizing. Galvanizing shall be in accordance with the provisions in Section 715, "Galvanizing," except that cabinets may be constructed of material galvanized prior to fabrication in conformance with the specifications of ASTM Designation A525, Coating Designation G90.

Iron or steel pipe standards and pipe mast arms shall be hot-dip galvanized after fabrication in conformance with the specifications of ASTM Designation A120.

Tie-rods, nuts, washers, clamps, and other miscellaneous ferrous parts shall be hot-dip galvanized after fabrication in accordance with the provisions in Section 715, "Galvanizing."

Not less than ten (10) inches of the upper end of the anchor bolts, anchor bars, or studs, and all nuts and washers shall be galvanized in accordance with the provisions in Section 715, "Galvanizing."

After galvanizing, the bolt threads shall accept galvanized standard nuts without requiring tools or causing removal of protective coatings.

Galvanizing of existing materials in an electrical installation will not be required.

623.02.16 Painting. Painting of electrical equipment and materials shall conform to the provisions in Section 614, "Painting," with the following additions and modifications.

Paint materials for electrical installation, unless otherwise specified, shall conform to the provisions in Section 714, "Paints."

Factory or shop cleaning methods for metals will be acceptable if equal to the methods specified herein.

In lieu of the temperature and seasonal restrictions for painting as provided in Section 614, "Painting," paint may be applied to equipment and material for electrical installations at any time approved by the Engineer.

All ferrous surfaces to be painted shall be cleaned as provided in said Section 614, "Painting," prior to applying the vinyl wash primer or prime coat. Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.

Existing equipment to be painted in the field, including State-furnished equipment, shall be washed with a stiff bristle brush using a solution of water containing two (2) tablespoonsful of heavy duty detergent powder per gallon. After rinsing, all surfaces shall be wire brushed with a coarse, cup shaped, power driven brush to remove all poorly bonded paint, rust, scale, corrosion, grease, or dirt. Any dust or residue remaining after wire brushing shall also be removed prior to priming.

Galvanized metal poles and metal guard posts will not require painting.

Two finishing coats of Aluminum Paint, Finish Coat, Section 714, "Paints," shall be applied to the following nongalvanized equipment: controller cabinets, reused lighting and signal standards, and reused luminaires; and to exterior surfaces and ungalvanized steel edges of raintight enclosures (switches, service, control equipment, transformers, etc.).

Interior of signal hoods, louvers, and front faces of back plates shall be finished with two (2) coats of Enamel; Traffic Signal, Lusterless, Black, as provided in Section 714, "Paints," except that factory enamel finish in good condition will be acceptable.

Painting of outside of signal heads and other signal equipment which have been factory enameled in dark olive green and are in good condition, may be omitted.

Factory finish on new equipment will be acceptable if of proper color and if equal in quality to the specified finish.

Conduit and conduit fittings above ground shall be prepared and finished in the same manner as the adjacent standard or post.

Signal heads, signal head mounting, brackets and fittings, outside of hoods, pedestrian push button housings, pedestrian signal head housings and hoods,

and back faces of back plates shall be finished with two (2) coats of Enamel; Traffic Signal, Dark Olive Green, as provided in Section 714, "Paints."

Reused equipment previously finished as specified in subsection 623.02.15, "Galvanizing," shall be given a spot finishing coat on newly primed areas, followed by one (1) finishing coat over the entire surface.

Reused galvanized equipment with extensively rusted areas shall be cleaned and painted as provided for nongalvanized equipment.

Small rusted or repaired areas of reused galvanized equipment shall be cleaned and painted as provided in Section 714, "Galvanizing," for repairing damaged galvanized surfaces.

New galvanized equipment shall not be painted.

All paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators. The work shall be done in a neat and workmanlike manner. The Engineer reserves the right to require the use of brushes for the application of paints, should the work done by the paint spraying machine prove unsatisfactory or objectionable, as determined by the Engineer.

CONTROLLERS

623.02.17 Controllers. A controller shall consist of a complete electrical mechanism for controlling the operations of traffic control signals, including the timing mechanism and all necessary auxiliary equipment, mounted in a cabinet.

All equipment inputs, outputs, and terminals shall be identified by the phase designations shown on the plans.

623.02.18 Interval Sequence. The color sequence of signal indications shall be green, yellow, red. During any interval there shall be no visual flicker of signal indications.

623.02.19 Flashing Operations. All controller cabinets shall be equipped for flashing operation of signal lights. Flashing operations, when required by railroad pre-emption, flashing control, or other causes, shall be set for flashing yellow lights on the main street or highway and for flashing red on the cross street or streets or left turn lanes, unless otherwise specified in the contract documents or directed by the Engineer.

623.02.20 Railroad Pre-emptor. The railroad pre-emptor shall pre-empt normal controller unit operation, or flashing operation as provided in subsection 623.02.31(j)5, "Police Panel Switches," when actuated by the normally closed track circuit or by a test switch. The pre-emptor shall cause the signals to display the sequence of indications shown on the plans. Once clearance sequence is begun it shall continue to the end regardless of the condition of the track circuit or test switch. After the track clearance interval the signals shall flash while the pre-emption circuit is actuated. When the track circuit or test switch is returned to its normal condition flashing operation shall terminate through the signal sequence shown on the plans. The controller shall go through the phase sequence shown on the plans as if calls

had been received on all phases. Pedestrian "WALK" indications shall appear with the first corresponding green indication.

623.02.21 Railroad Pre-emption Equipment. The pre-emptor shall consist of solid-state components and circuits. Solid-state circuitry shall conform to the material requirements specified in subsection 623.02.24, "Traffic Actuated Controllers."

The pre-emptor shall be a module which plugs into the controller unit, or a separate unit built on a shelf mounted chassis which is connected into the controller through an "MS" connector.

The controller shall operate only in the flashing mode when the pre-emptor is removed.

The pre-emptor shall be provided with timing controls for the intervals shown on the plans. Pilot lights shall indicate which interval the pre-emptor is in. Means shall be provided to turn the pilot lights on and off.

A momentary contact, normally closed switch shall be installed in series with the track circuit to provide a means to test the pre-emptor.

Relays and flashers shall be as specified for controllers. During pre-emption of normal signal operation, the signal lights may be switched by the normal load switching devices.

623.02.22 Operating Voltage. All traffic signal equipment, except pedestrian push buttons, shall be designed to operate from a one hundred twenty (120) volt, sixty (60) Hz, AC supply. Operation shall be satisfactory at voltages from one hundred five (105) to one hundred thirty (130).

The voltage for pedestrian push buttons shall not exceed eighteen (18) volts.

623.02.23 Radio Interference Suppressors. Each traffic controller unit, flasher, and other current interrupting device shall be equipped with a suitable radio interference suppressor installed at the input power point. Interference suppressors shall be of a design which will minimize interference in both broadcast and aircraft frequencies, and shall provide a minimum attenuation of fifty (50) decibels over a frequency range of two hundred (200) kilocycles to seventy-five (75) megacycles when used in connection with normal installations. The interference suppressor shall be hermetically sealed in a substantial metal case filled with a suitable insulating compound. Terminals shall be nickel-plated, ten (10) to twenty-four (24) brass studs of sufficient external length to provide space for connecting two (2) No. 8 AWG conductors, and shall be so mounted that the terminals cannot be turned in the case. Ungrounded terminals shall be properly insulated from each other, and shall maintain a surface leakage distance of not less than one-fourth (1/4) inch between any exposed current conductor and any other metallic part, with an insulation factor of one hundred (100) to two hundred (200) megohms dependent on external circuit conditions. Suppressors shall be designed for one hundred twenty-five (125) percent of the total connected load and in no event less than twenty-five (25) amperes, one hundred twenty (120) volts, sixty (60) Hz, single-wire circuits, and shall meet standards of the UL and the EIA.
[18]

623.02.24 Traffic Actuated Controllers. (a) General Requirements:

1. The controller supplied under these specifications may be modular or nonmodular in construction with all phases or function timing sections identified to the phase(s) it controls.

2. The controller supplied shall meet requirements of the NEMA Standards Publication, TS1, current edition.

3. Modular controllers shall be microprocessors, supplied in main frame construction as follows:

a. Two Phases Active. Two (2) or four (4) phase main frame with all phase modules supplied.

b. Three or Four Phases Active. Four (4) phase main frame with all four (4) phase modules supplied.

c. Five to Eight Phases Active. Eight (8) phase main frame with all eight (8) phase modules supplied.

4. Nonmodular controllers shall be microprocessors, supplied in two (2), four (4), or eight (8) phase configurations using pushbutton keyboard entry system for selectable and setable timing periods.

5. All timing and addressing functions of the controller shall be performed using digital techniques in accordance with the NEMA Standards.

6. All circuits shall consist entirely of solid state electric circuitry. No vacuum or gaseous tubes may be used in any timing circuits. No electromechanical devices, such as camshafts, rotary, stepping, or line switches may be used for switching functions.

7. Circuits shall be designed using MOS or CMOS components. All components used shall have at least two (2) sources of supply. Memory chips that are programmed by the manufacturer may be single source.

8. The timing circuits shall be designed so that the length of any interval, portion, period, or extension shall correspond to the accuracy of the sixty (60) Hz source without variance.

9. The controller and all associated equipment shall be designed for use on one hundred twenty (120) VAC, sixty (60) Hz source.

(b) Visual Monitoring Indications:

1. All indicator lights required in Section TS1–4.3.5 of the NEMA Standards shall be provided for controller function observation. The "Call" lights shall be located with their respective phase on modular units and shall be provided for all phase intervals on nonmodular units. "Call" lights and interval indications shall be displayed without the necessity of calling up stored information.

2. Keyboard address instructions shall be provided on nonmodular controllers to verify phase and settable timing period readouts without the necessity of halting the controller timing.

(c) Phase Module Description:

1. The following phase modules shall have the timing period indicated. The timing ranges shall encompass those specified by the NEMA Standards.

a. Type 11 Phase Modules. Type 11 phase modules shall be nonvolume density without pedestrian feature. Type 11 modules shall provide the following functions:

Minimum green

Passage time
Maximum green
Vehicle clearance
All red clearance

b. Type 12 Phase Modules. Type 12 phase modules shall be nonvolume density with pedestrian features. Type 12 phase modules shall provide the following functions:

Minimum green
Passage time
Walk
Pedestrian clearance
Maximum green
Vehicle clearance
All red clearance

c. Type 22 Phase Modules. Type 22 phase modules shall be volume density with pedestrian features. Type 22 phase modules shall provide the following functions:

Minimum green
Passage time
Walk
Pedestrian clearance
Time to reduce to minimum gap
Minimum gap
Actuations before added initial
Seconds per actuation
Maximum green
Vehicle clearance
All red clearance

d. Nonmodular keyboard address instruction shall provide type 22 phase timing periods on all phases.

e. All controllers shall have button or switch selection of the following options, located on the front panel: vehicle recall, pedestrian recall, nonlocking detector memory, and recall to maximum timing. These features shall be for all phases.

(d) Controller Construction:

1. All active devices used for logic, timing, or control functions shall be solid state in design and be sufficiently derated to ensure no material shortening of life under conditions of maximum power dissipation at maximum ambient temperatures.

2. Individual components shall be grouped and soldered to epoxy glass printed circuit boards with two (2) ounce or better copper track, forming modular plug-in assemblies, internal to the controller, on nonmodular units, and in main frame slots on modular units. These assemblies, when collectively grouped, shall have a mean-time-to-failure of not less than three (3) years. The design life of individual components, under twenty-four (24) hours per day operation in the circuit applications, shall be less than five (5) years.

3. Power failures between five hundred (500) and one thousand (1,000) milliseconds shall have no material effect on the controller and it shall

continue to operate in a normal manner. If the power is disrupted in excess of five hundred (500) milliseconds, when restored, the controller shall resume timing in its programmed start-on interval.

4. Temperature. All solid state equipment shall be designed to operate satisfactorily over the range of minus thirty (30) to plus one hundred sixty-five (165) degrees F.

5. Humidity. All solid state equipment shall be designed to operate satisfactorily in up to ninety-five (95) percent relative humidity.

6. Dust Resistance. All solid state equipment shall be designed to prevent dust or dirt from entering the enclosed solid state components.

7. Microprocessor. The controller's timing, decision making, and control elements shall utilize a stored program microcomputer. The microcomputer system shall encompass, but not be limited to, a microprocessor unit (MPU), a programmable read-only memory (PROM), and a read-alter memory (RAM), which together store the computer programs and data necessary to operate the MPU, a clock generator that provides MPU timing, a real-time clock that provides controller interval timing, flexible input/output circuitry that provides interface to traffic sensors and traffic lights, and special function commands.

8. Inputs/Outputs. Inputs and outputs related to external devices in the cabinet shall be related to the pin assignments prescribed by NEMA and shall not require cabinet modification for interchangeability with NEMA controllers. Any special functions required for controller operation shall utilize spare pins in the input/output connectors as specified by NEMA.

9. Controller Sequence Reversal. Dual ring controllers shall be capable of phase sequence reversal by applying a ground true signal to connector B pins W and X of the controller. Applying ground true signal to pin W shall cause the controller to reverse sequence phases 1 and 2 (lead-lag). Applying ground true signal to pin X shall cause the controller to reverse sequence phases 5 and 6 (lead-lag). Applying a ground true signal to both pins W and X simultaneously shall cause the controller to sequence to phases 2 and 6 before phases 1 and 5 (lagging left turns).

10. System Control. A controller phase type 12 or 22, operating in a call to nonactuated mode 1 or 2, with the phase hold active, and the walk rest modifier input active, shall rest in a walk dwell condition until a yield (release of the phase hold input). Upon a yield the controller shall be capable of timing the pedestrian clearance interval followed by the vehicle clearance interval, and all red interval without the need for other input control such as a force-off. The controller shall be capable of responding to yield durations of five hundred (500) milliseconds and perform the said function.

623.02.25 Traffic Actuated Controller Cabinet. Each traffic actuated controller unit and auxiliary equipment shall be housed in a weatherproof aluminum, steel, or other approved metal cabinet or cabinets, as shown on the plans and as described herein.

(a) General Requirements. All cabinets shall be provided as a complete unit to include all shelves, foundations, anchor bolts with template, locks, door stops, etc., and to be completely painted as specified on each cabinet standard drawing.

1. All cabinets shall be weatherproof, properly ventilated, and have a vent fan as specified. All cabinets shall have each and every door mounted with hinges welded to door and jamb.

2. The type of cabinet to be furnished shall be as specified in the contract documents.

3. Each cabinet must fit the anchor bolt locations and foundations as specified on the standard drawings, without modification to the cabinet or foundation.

4. All cabinet wiring shall be neat and firm and all harnesses and cabinet wiring shall be laced or bound together with TY–WRAP or equivalent.

5. All terminals shall be numbered and identified in accordance with the cabinet wiring diagram.

6. Wiring diagram prints shall be furnished for each cabinet, reproduced from a reproducible drawing provided by the manufacturer, pursuant to subsection 623.01.03. The cabinet shall be equipped with a plastic envelope to house one (1) or more cabinet wiring diagrams.

7. The cabinet wiring diagram shall show and identify the connectors for all equipment and switches, relays, flashers, and signal control bases.

8. The cabinet wiring diagram shall also have an intersection sketch with heads, detectors, and pushbuttons identified and a Signal Sequence Chart identified and related to the intersection sketch.

9. All mechanical relays shall have clear covers.

10. The following terminals, wiring, and switches shall be furnished for all cabinets:

a. A single pole circuit breaker, plug-in type, for control of all power to the controller and its auxiliary equipment. There shall be a terminal, unfused, for neutral side of the power supply line.

b. Terminal blocks for connection of traffic and pedestrian signal light field wires not specified for flashing operation.

c. Terminal blocks for connection of traffic and pedestrian signal light field wires specified for flashing operation.

d. Terminal blocks for connection of detector amplifiers, detectors, and pedestrian pushbutton field wires.

e. Copper ground strip, mounted and grounded to cabinet wall, for connection of all common conductors.

f. Terminal blocks for connecting cable tie points and intercabinet terminations. Also a terminal block or terminal blocks (depending on intersection requirements) for terminating the traffic computer system interconnect cable. This block or blocks shall be telephone type Reliable Electric #R66B4–25 or equivalent.

g. A two (2) circuit solid state jack mounted flasher, having a minimum flashing rate of fifty (50) to sixty (60) flashes per minute. The flasher circuits shall be wired in the cabinet in accordance with the standard auxiliary cabinet equipment wiring drawing.

h. Convenience Outlet and Voice Communication Phone Jacks:

(1) A duplex "u" ground type of convenience outlet shall be furnished for test equipment, tools, and lighting. It shall have an integral ground fault protection device.

(2) Two (2) phone jacks shall be furnished and identified as "TMC" and

"JMC" and shall be wired to the interconnect terminal block. (In Las Vegas area only. One (1) phone jack in all other areas unless otherwise indicated on the plans.)

i. Switches Behind Police Auxiliary Door. "Auto-flash" switch, identified "auto-flash," wired to deenergize signal light power and place signals on "flash," but to keep controller power energized during the flash period. When the "auto-flash" switch is placed in the "flash" position, the stop-time device required within paragraph (c) "Conflict Monitor," shall be activated to store and display the indication that the "auto-flash" switch was triggered.

j. Interior Cabinet Switches:

(1) "Main switch," identified "on-off," wired to deenergize both controller and signal light power when switched to "off" position.

(2) "Test switch" three position switch (or equivalent) identified "auto-off-flash," wired to deenergize controller power during "off" and "flash" positions.

(3) The test switch, main switch, voice communication phone jacks, and convenience outlet may be combined on a single panel and preferably mounted on the cabinet door behind the police auxiliary panel.

k. Radio line filter or filters for filtering AC+ lights and control power for solid state light control and controller operation.

l. Thyrector or gas filled surge protector for filtering lightning or high voltage surges to ground for protection of solid state components.

(b) Additional Cabinet Equipment.

1. Cabinet types M–1 and R shall have a top mounted fan as specified.

2. Each type D and type G cabinet shall have a top mounted fan only when specified on the traffic signal drawings or the special provisions.

Each type D and type G cabinet shall be ventilated if a fan is not a requirement.

3. Type M–1 and type R cabinets shall have a fluorescent fixture and light mounted in the cabinet interior, preferably over the door, at a location least likely to be damaged. The length shall be determined by the cabinet width. The fixture shall have an on-off switch operated automatically with light on when door is opened and off when the door is closed.

4. Each cabinet shall have a vehicle and pedestrian detector test panel located on the inside of the cabinet door, equipped with toggle switches and pushbuttons, wired for permitting the introduction of manual calls into each controller vehicle or pedestrian detector input. The toggle switch, in one (1) position, shall permit calls into the controller for vehicle and pedestrian detectors. The toggle switch, in one (1) position, shall disconnect the vehicle and pedestrian detectors and permit calls into the controller via manual push button actuation. Each vehicle and pedestrian detector circuit shall have a separate toggle switch and manual push button. Toggle switches and push buttons shall be provided for all future phases and wired to the terminal blocks.

5. Type M–1 cabinets shall have a hook type door stop. The hook end shall be at least one and one-half (1½) inches long.

Type R cabinets shall have a door stop device located at the top or bottom of the door that will allow securely fastening the door opened to ninety (90) or one hundred eighty (180) degrees.

6. A conflict monitor as hereinafter described shall be installed in each traffic signal cabinet.

7. Load switches as hereinafter described shall be installed in each traffic signal cabinet.

8. All necessary cabinet wiring, connecting cables, and support bases shall be provided for all future vehicle and pedestrian phasing possible for each specific controller. Phase overlaps shall be provided when specified on the traffic signal drawings.

a. A loadswitch shall be provided with each support base for future operation.

b. The cabinet wiring diagram shall include clear instructions for expansion to the additional phases and all wiring to be changed or removed shall be tabulated. It shall not be necessary to add wiring to expand phases.

9. A local communications interface panel shall be furnished. This panel and its purpose is described in subsection 623.02.27 of these specifications.

10. Terminal blocks shall be provided for connection of a minimum of sixteen (16) loop amplifier connecting cables (one hundred sixty (160) terminals) in each "Type R" cabinet. Other cabinet sizes shall require twenty (20) spare terminal block terminals for future loop amplifiers. Additional terminal blocks shall be provided for loop amplifier connecting cables required for local traffic computer systems and counter detectors. The number of additional loop amplifier connecting cables required shall be specified on the traffic signal drawings or in the special provisions.

(c) Conflict Monitor.

1. The conflict monitor shall be a self-contained solid state device capable of detecting conflicting signal displays and/or improper power supply voltage from the controller.

2. The unit shall monitor for conflicting indications during the green, amber, and walk of each phase and be programmable to designate the conflicting phases. The unit shall also monitor all red signal sections on each approach of each phase; a conflict shall be indicated if all red signal lamps on any single approach are dark. All monitoring shall be done on the field side of the cabinet wiring terminals.

3. When the monitor is triggered as a result of sensing conflicting indications, or the "auto-flash" switch is switched to "flash," the monitor shall place the intersection into emergency flash, stop time the controller, and store and display the conflicting indications experienced at the moment of the conflict on the front of the unit. The monitor shall retain this operation until reset by a front panel pushbutton.

4. When the monitor is triggered as a result of sensing a supply voltage error, it shall place the intersection into emergency flash and retain this operation until reset by the front panel pushbutton or restoration of proper power.

5. The sensitivity of the threshold level shall be twenty-five (25) plus or minus five (5) volts AC. Voltage levels above thirty (30) VAC shall be sensed while voltages below twenty (20) VAC shall not be sensed. The monitor shall not trigger until the conflict has been sensed for more than one hundred (100) milliseconds.

6. All five (5) to eight (8) phase cabinets shall have a conflict monitor wired for all eight (8) vehicle and four (4) pedestrian phases.

7. The conflict monitor shall be capable of outputting a ground true signal when in a conflicted condition. This output shall be wired to the communication interface panel terminal.

8. The conflict monitor shall meet the requirements of current NEMA Standards Publication No. TS1, Part 6.

(d) Load Switches.

1. The interface between the controller and the vehicle and pedestrian signals shall be accomplished through solid state load packs. Each load pack shall have three (3) solid state switches in a modular assembly for opening and closing the connection between applied power and the traffic signals.

2. The load switch(es) shall conform in its entirety to the current NEMA Standards Publication No. TS1, Part 5.

623.02.26 Traffic Pre-empting Devices.

(a) Pre-empt System Designation.

1. The pre-empt system is intended to identify the presence of designated priority vehicles and shall enable such vehicle to remotely cause the traffic signal controller to advance to and/or hold a desired traffic signal display by using existing controller functions, the control shall be effective for a distance of up to one thousand eight hundred (1,800) feet along an unobstructed "line of sight" path. When the optical emitters are equipped with a visible light filter, the control is effective for a distance of up to one thousand (1,000) feet.

2. The pre-empt system shall utilize optical pulses transmitted at the rate of fourteen and thirty-five one-thousandths (14.035) Hz plus or minus twenty-five one-hundredths (0.25) Hz.

3. No distinction is made between the various vehicles that are equipped with optical emitters. One (1) timing strategy is used to yield the same level of priority for all classes of optical emitter equipped vehicles unless otherwise provided in the plans or the special provisions.

(b) Functional Elements. The pre-empt system shall be comprised of three (3) basic functional elements.

1. Optical Emitter Assembly. An emitter and a control for transmitting a predetermined signal indicating the approach of the priority vehicle.

2. Optical Detector. An optical detector capable of directionally detecting the predetermined transmitted signal.

3. Phase Selection. a. Equipment for remotely controlling a traffic signal control system which controls a set of traffic signal lights.

b. The equipment shall be operatively coupled to the optical detector and to the traffic signal controller.

c. The equipment shall include sensing circuits for operative coupling to the traffic light thereby sensing the phase of the traffic light.

d. The equipment shall respond to both the detected direction of the predetermined signal and the sensed phase of the traffic light and cause the traffic signal controller to operate in a selected phase.

(c) Pre-empt System Operation.

1. The system shall, in response to an optically transmitted predetermined signal of fourteen and thirty-five one-thousandths (14.035) Hz or upon the actuation of a test switch, cause the traffic signal controller to select and either hold a preselected green indication or advance to and hold that green indication.

2. The system shall not be interposed between the traffic signal control unit and the traffic signal light displays.

3. The system shall cause the traffic signal control unit to select one (1) of its available green phases by activation of a combination of its normally available inputs such as stop time, manual, force off, manual control enable, interval advance, phase omit, and vehicle detector.

4. The system when activated shall provide a ground true signal to the communications interface panel. Where dual pre-emption exists, the system will provide a ground true to the communication interface panel for each pre-emption activation. These outputs shall be wired to pre-empt 1.

5. The system shall not compromise the existing fail-safe or conflict monitoring provisions of the controller.

6. The equipment manufacturer shall not modify the existing traffic control equipment to alter its capabilities beyond adding the remote control feature.

7. The pre-empt system shall not cause the traffic control assembly to display any signal for less than is acceptable to the Engineer.

a. Minimum green times shall be provided on phases that are to be terminated in response to a priority demand.

b. Green displays that appear to be not timed or changes from red to yellow to red with no apparent omission of a minimum green display are not allowed.

c. Transitions from green to red without an appropriate yellow change interval are not allowed.

d. Minimum acceptable displays of pedestrian walk and flashing don't walk shall be maintained on phases that are to be terminated.

8. The system shall cause the controller to advance to and/or hold the desired traffic signal display even if the optical energy signals cease before the desired display is obtained unless the demand is overridden by a higher priority demand.

9. The system shall begin the process to allow the traffic signal controller to resume normal operation within ten (10) seconds after optical energy signals cease or the optical energy signals cease after the desired traffic signal display is obtained.

10. The presence of a priority demand shall be held in the system as long as the conditions of a valid signal remain present on the called channel.

11. The system shall be designed so that it can only act upon a priority demand for a traffic signal phase or nonconflicting phase pair at any one time.

(d) Pre-empt System Component Specifications.

1. Emitter Assembly (shall be furnished by others).

a. Shall be pulsed optical energy source with a controlled repetition rate producing pulses of relatively fast rise time.

b. Shall be capable of producing high priority pulses of fourteen and

thirty-five one-thousandths (14.035) Hz plus or minus twenty-five one-hundredths (0.25) Hz as determined by the frequency setting of the emitter control.

c. Shall be controlled by a single on/off switch which requires no other setting or adjustments by the operator. The on/off condition shall be indicated by a light located adjacent to the on/off switch on the emitter control assembly.

d. Shall operate on ten (10) to fifteen (15) volts DC input voltage, but shall not be damaged by sustained input voltages up to twenty-five (25) volts DC.

e. Shall not weigh more than four and five-tenths (4.5) pounds.

f. Shall not exceed the following physical dimensions:

LENGTH	5¼ inches
HEIGHT	6⅝ inches
WIDTH	7 inches

g. Shall operate over an ambient temperature range of minus thirty (30) to plus one hundred forty (140) degrees F. without the use of an internal or external heater.

h. Shall operate in zero (0) to ninety-five (95) percent humidity.

i. Shall not exceed current consumption of five (5) amps.

j. Shall not emit visible light exceeding an average of three ten-thousandths (0.0003) candles per flash when the emitter is equipped with a visible light filter in the wave length range of three hundred eighty (380) to seven hundred fifty (750) nanometers.

2. Optical Detector.

a. Shall be solid state construction.

b. Shall have internal circuitry encapsulated in a semi-flexible compound to insure moisture resistance.

c. Shall be capable of receiving optical energy signals from either one (1) or both of two (2) axially opposed directions.

d. Shall contain internal circuitry to prevent electrical outputs due to steady state ambient light.

3. Phase Selection Equipment.

a. Shall use primary solid state electrical components, but in no case use more than four (4) electromechanical relays.

b. Shall have two (2) channel operation with the capability of interfacing with an additional phase selector for expansion of channels of operation.

c. Shall be compatible with currently manufactured high priority detection equipment to allow expansion to dual priority operation at a future date.

d. Shall have a maximum of three (3) standard "MS" type connectors, one (1) for the main wiring harness to the controller, and one (1) for each channel optical detector connection.

e. Shall have control for adjusting the pulse width of the advance of "manual" pulses.

f. Shall be capable of providing signals such as stop time and advance or "manual" pulses to manipulate the controller to advance to and/or hold the desired traffic signal display.

g. Shall have RC digital timing controls for each channel which adjusts

the time between advance pulses during yellow displays from at least one (1) to ten (10) seconds in one (1) second steps.

h. Shall have RC digital timing controls for each channel which adjust the time between advance pulses during non-yellow displays from at least one (1) to ten (10) seconds in one (1) second steps.

i. Shall have a control that is capable of multiplying the time setting by two (2).

j. Shall have solid state indicator light to indicate power on, signal being received, channel called, and advance circuit operation.

k. Shall be capable of automatically placing a call on a predetermined channel after servicing a call on another channel (recall).

l. Shall have switches to control system power, activate "recall," test the phase selector advance operation, and to multiply timing control settings by two (2).

4. Pre-empt System Interface.

a. When additional interfacing beyond two (2) external relays is required, it shall be housed in a pre-empt system interface unit.

b. The pre-empt system interface unit shall:

(1) Have the capability to allow mounting sixty (60) dual terminals rated at three hundred (300) volts to allow making connection between internal logic and external sources.

(2) Have provision for mounting up to eight (8) card edge sockets for mounting and wiring to the various logic elements of the system interface unit.

(3) Have one (1) connector to provide input/output connections for interfacing with the controller assembly.

(4) When more than one (1) interface unit is used in a particular installation, the units shall be individually keyed to preclude connection to the wrong harness assembly.

(5) The system interface unit dimensions shall not exceed those of the phase selector.

(e) Reliability.

1. All controller cabinet equipment supplied as part of the remote control system must meet the NEMA environmental specifications spelled out in current NEMA Standards Publication No. TS1, Part 2:

TS1-2.1.02	Voltage
TS1-2.1.03	Frequency Range
TS1-2.1.04	Power Interruption
TS1-2.1.05	Temperature and Humidity
TS1-2.1.06	Transients Power Service
TS1-2.1.07	Transients Input/Output Terminals
TS1-2.1.08	Nondestruct Transient Immunity

2. All equipment mounted externally to the intersection control equipment cabinets or the priority vehicle must operate properly under any combination of the following environmental conditions without the use of internal or external heating devices.

Temperature	—30 to +140 degrees F.
Relative Humidity	0 to 95 percent

(f) Installation.

1. The pre-empt system equipment manufacturer shall be responsible for "Pre-empt System Design and Documentation." Pre-empt system design and documentation includes the following:

a. Design controller interface logic to generate an interface diagram that indicates the recommended interface technique.

b. Provide the installing agency and using agency with interface diagram.

2. The installer shall install the equipment consistent with the equipment manufacturer's recommended installation procedures and interface diagrams in a neat and workmanlike manner.

3. The equipment manufacturer shall be responsible for "Pre-empt System Checkout" prior to final acceptance and approval by the purchasing and/or using agency (agencies). Pre-empt system checkout includes the following:

a. Verifying that the system is properly installed per the manufacturer's recommendations and the interface diagrams as provided by the equipment manufacturer.

b. Verifying that the priority system timing and range are properly set.

c. Pre-empt system warranties are put into effect.

d. Instructing the emergency vehicle drivers or their representative(s) in the operation of the system.

e. Instructing maintenance personnel in routine maintenance of the system.

(g) General.

1. Manufacturer shall replace or repair, without charge, any component parts that prove to be defective within one (1) year after installation. Manufacturer shall certify upon request that all materials furnished will conform to this specification.

2. The traffic pre-empting devices shall be installed at the locations shown on the plans.

623.02.27 Local Traffic Computer System Coordination Equipment. (a) General. Unless otherwise provided in the plans or special provisions, each traffic controller cabinet furnished for the Las Vegas area computerized traffic control system shall conform to the requirements of this subsection. The controller cabinet shall be equipped for its intended intersection with a local communications interface unit (LCIU) panel, communication unit, and harnesses. The LCIU interface panel and harnesses are to be wired in accordance with the attached listing and wiring diagram. The communication unit to be used shall be a Sonex Model PTC–122A (or approved equal) configured for the Las Vegas area computer traffic system. Detector harnesses are to be wired in the cabinet as per the project plan requirements. System, count, and local detectors will be utilized.

(b) LCIU Interface Panel. The interface panel will be constructed with the LCIU harnesses wired to the back of the panel, and the cabinet interface wiring to the front of the panel. The interface panel shall have seven (7) terminal strips having binder screws on the top and solder terminals underneath. All wires of the LCIU harnesses shall be terminated to the solder side of the terminal strips. The terminal strips shall be TRW Cinch Jones series

25–141–Y terminals or equivalent. The LCIU harnesses shall have three (3) connector ends to mate with the Sonex PTC–122A unit. The connectors shall be AMP "CPC" series connectors, and wired as required.

(c) Voice Communications. Each controller cabinet shall have two (2) phone jacks installed for the purpose of voice communication. One (1) jack shall be labeled "TMC," the other "JMC," and shall be wired to the interconnect cable terminal block as required. Phone jacks shall be Switchcraft J–12B or equal.

(d) Interconnect Cable Termination. Each controller cabinet shall have a telephone terminal block for terminating the system interconnect cable. The terminal block shall be a Reliable Electric #R66B4–25 or equivalent. The cabinet shall have an ample number of terminal blocks to terminate all system interconnect cables for a given intersection. Each wire pair from the interconnect cable utilized in the cabinet shall have surge protectors installed to shunt power surges to ground, i.e., RX COMM IN, TX COMM OUT, VOICE (TMC), and VOICE (JMC). The surge protector devices shall be TII #317A protectors or equivalent.

(e) Detectors-System Count, Local. Intersection cabinets shall be wired with loop detector harnesses and terminal blocks for a maximum of eight (8) system detectors, eight (8) count detectors, and as many local detectors to accomplish the needs for a given intersection detection system. All detector outputs (including pedestrian detectors) will be diode isolated to provide the purpose of dual function, i.e., controller input and LCIU Input. All diodes are to be interfaced and mounted to terminals in a neat and workmanlike manner. TB20–10 through 25 of the LCIU interface panel can be used for system and count detector diode isolation. Loop detectors within an intersection detector system used for system and count detectors will be specified in the plans for a given intersection.

(f) Pre-emption. Intersection cabinets utilizing pre-emption equipment shall be wired in such a manner that the outputs wired to controller and cabinet functions which are common to the outputs of the LCIU shall have proper isolation devices (relay or diode) to prevent improper operation of either unit. Pre-emption outputs shall also be wired to the pre-empt 1 input to the LCIU for traffic system surveillance purposes.

(g) Controller Phasing. The LCIU inputs related to controller phasing, i.e., 1–8 grn, 1–8 yel, 1–8 red, 9–12 walk, 9–12 ped clr, 9–12 d'wlk, refer to compass directions of an intersection rather than actual controller phases. Controller phase outputs to LCIU inputs wiring shall be unique for each intersection cabinet based on the compass directions for an intersection.

(h) System Control Functions. Hold on line (H.O.L.). The hold on line output shall be wired to the max inhibits 1 and 2 of the controller, and the call to nonactuated 1 input of the controller. Controller phases 2 and 6 shall be enabled for call to nonactuated 1.

Yield. The yield output will be wired to the hold inputs for controller phases 2 and 6. The yield output shall be active only when the H.O.L. output is active. The actual yield condition shall be a release of the hold inputs to the controller.

Force Off 1 and 2. The force off outputs shall be wired to the force off inputs 1 and 2 of the controller.

Call All. This output shall be wired through isolation diodes to the vehicle call inputs for all phases of the controller.

Special Function 3. This output when active shall cause the controller phases 1 and 2 to be reversed in sequencing, making the controller operate in a lead-lag situation.

Special Function 4. This output when active shall cause the controller phases 5 and 6 to be reversed in sequencing, making the controller operate in a lead-lag situation, but opposite of special function 3. When both special functions 3 and 4 are active simultaneously, the controller will operate in a lagging situation, i.e., phases 2 and 6 first, then phases 1 and 5.

Flash Command. This output shall be wired to the flash control line of the cabinet. When this output is active (AC+), the intersection cabinet shall be put in a flash mode.

Walk Rest Modifier. This controller input shall be wired to logic ground in the cabinet.

The following LCIU output functions shall be terminated on the LCIU interface panel for the capability of future use:

Offset Command, Offset 1, Offset 2, Offset 3, Cycle Command, Cycle 2, Cycle 3, Special Function 1 and 2 Relay Outputs, and Advance.

(i) System Monitoring Functions. Both DC and AC inputs are required for the LCIU. The following is a list of inputs and required levels:

DC Inputs, Ground True	
36	Phase Returns (grn, yel, red, pedestrian)
1	Pre-empt 1
1	Pre-empt 2
1	Conflict Flash
4	Pedestrian Calls
8	Local Detectors
8	System Detectors
8	Count Detectors
AC Inputs (115 VAC)	
1	Controller Flash

The local detector inputs shall be wired to the respective phase check outputs of the controller.

(j) Central Communications Modem. A Sonex modem PC board #30201A-301 shall be required to expand the central communications equipment to add an intersection(s) to the traffic computer system.

(k) Map Display—Traffic Management Center (T.M.C.). Two (2) map lamp driver PC boards (one (1) master, one (1) slave) #2000-803B shall be required to expand the system display map control electronics when adding an intersection to the traffic computer system. Also required shall be a lamp socket assembly for each intersection and each set of system detectors.

(l) Map Display—Jurisdictional Management Center (J.M.C.). The same parts requirement listed above for the T.M.C. shall be required for the corresponding J.M.C. map display.

(m) Interconnect Junction Cabinets. The interconnect junction cabinet shall be a Tesco Cabinet Class 22-000-NR forty-three (43) by twenty (20) by

eleven (11) inch or approved equal, equipped with one (1) Reliable Electric N. R66B4–25 terminal block, or approved equal, having the capacity for twenty-five (25) pairs of No. 22 AWG wire. The terminal block shall be mounted on a painted wood panel secured to the back of the cabinet. The Contractor shall provide and install a door lock with key and all foundation, anchor bolts, and hardware in accordance with instructions of the cabinet manufacturer.

623.02.28 Time Base Coordination Unit. The unit shall provide for coordination of signalized intersections without the use of the interconnect cable. The unit shall use the latest technology solid state circuitry as specified in the special provisions.

623.02.29 Blank.

623.02.30 Pre-Timed Controller Units. Pre-timed controller units shall be the expansible type designed to permit the installation of plug-connected dial units without additional wiring or modification of the controller unit. Controller units shall be 1-dial, 2-dial, or 3-dial. The types of pre-timed controller units, number of dials, cabinets, and auxiliary equipment shall be as shown on the plans or specified in the special provisions. Solid state pre-timed controllers will be acceptable.

(a) Controller Units. Pre-timed controller units shall be of the following types:

1. Type XXV Controller Units. Type XXV controller units shall be the future interconnected type and shall be capable of being operated as future units in an interconnected, master controlled flexible progressive system by the addition of easily installed auxiliary attachments.

2. Type XXVI Controller Units. Type XXVI controller units shall be the interconnected type; shall be capable of being operated as units in an interconnected, master controlled flexible progressive system; and shall have three (3) offsets per dial, unless otherwise specified in the special provisions.

3. Type XXVII Controller Units. Type XXVII controller units shall be the combined master and intersection interconnected type and shall be similar to Type XXVI controller units, except that the Type XXVII shall be equipped with master offset supervision, dial change, offset selection, and flashing operation of the intersection controllers.

(b) Operations. All pre-timed controller units shall be capable of being operated by manual control; as a pre-timed controller of the independent, isolated type; and as a synchronous-motor-driven coordinated type, for progressive timing without interconnecting circuits.

(c) Mechanism for Pre-Timed Controller Units. Mechanism for pre-timed controller units shall be constructed as a complete, self-contained, readily interchangeable unit arranged to swing out for inspection while in operation. All parts shall be readily accessible.

All circuits of each unit shall be terminated in a multiple-contact connector. Connection between the connector and the panel or field terminal board shall be by means of a flexible cable. Panel or field terminal board end of the conductors shall be fitted with proper terminals. Each field terminal shall be identified.

(d) Motor and Dial. Controller unit motor shall be of the self-starting, synchronous type, and shall have ample torque for the requirements of the controller operation.

All intervals in each phase shall be readily adjustable by a suitable dial on the face of the controller unit. Intervals shall be adjusted in steps not to exceed one (1) percent of the total cycle by means of self-retained timing keys.

Each dial unit shall consist of motor, dial with slots for timing keys, contact block, motor switch, and connector for plug-in mounting of the entire dial unit assembly. Design of the dial unit shall allow gear changing without tools or with simple tools. The cycle length of the gear used shall be indicated on the face of the dial unit when the gear mesh is correct. Gears shall be brass.

A suitable dust cover shall be provided for the timing mechanism. Dial key settings shall be visible without the necessity of removing the cover.

Color code of dial keys shall be as follows:

Drum Release	Green
Drum Advance	Unpainted
Offset 1	Red
Offset 2	Yellow
Offset 3	White

(e) Signal Contact Mechanism. All parts of the contact mechanism for signal lights, including contacts and contact supports, shall operate one million (1,000,000) times without mechanical wear that impairs normal operation.

All signal light contact points shall be of fine silver, silver alloy, or superior alternative material not less than five-sixteenths ($^5/_{16}$) inch in diameter; shall be of not less than ten (10) ampere capacity, capable of operating one million (1,000,000) times without excessive burning or pitting; and shall be easily removed and replaced.

Cam or drum assembly shall provide not less than twelve (12) intervals, all necessary contacts, and provisions for not less than a total of fourteen (14) signal light contacts. Wiring shall be complete from terminal strip to each contact position.

(f) Auxiliary Equipment. Each pre-timed controller unit shall be equipped with a complete set of brass gears for each dial fifty (50) to one hundred twenty (120) seconds, inclusive, in ten (10) second steps.

1. Controls. Switches shall provide local control of the following functions:

a. Transfer from automatic to manual operation and vice versa.

b. Transfer from normal operation to flashing and vice versa.

c. Transfer from one dial to another.

d. Turn-off signal lights only without shutting down controller unit mechanism.

e. Shutdown timer mechanism.

Combined master and intersection controller units shall have additional switches properly marked for functions b and c above and for offset selection for the interconnected system. Switch for local control of function c is not required at the master.

Combined master and intersection controller units shall also have provisions for time switch or program device control of functions b and c above and for offset selection for the interconnected system.

Interconnected controller units shall have relays and wiring for remote control of functions b and c above and for offset selection.

Future interconnected controller units shall have provisions for local time switch control of functions b and c above and for offset selection.

2. Offset Interrupter. Each Type XXVI controller unit shall be provided with an offset interrupter which, during reset of time cycle to the master synchronization pulse, shall limit the length of the dwell in any one (1) cycle. Interrupter shall have five (5) second, minimum, increments, and shall have a range of forty (40) seconds, minimum.

Timing adjustments shall be made without the use of tools and shall have an accuracy of plus or minus ten (10) percent of the setting over the full range. Timer shall be plug-in mounted.

A switch shall be provided to bypass the interruption feature.

Removal of the interrupter shall not affect the operation of the Type XXVI controller unit.

3. Flashers. Each pre-timed controller unit shall be wired and furnished with a plug-in-mounted flasher and provisions for jack-mounted relays conforming to the provisions in subsection 623.02.25, "Flasher and Flasher Relay."

Plug-in-mounted flasher and jack-mounted relays for flasher shall be independent of the controller unit and shall remain in operation upon the shut down of the controller or removal of the controller unit from the cabinet.

4. Manual Control. Each pre-timed controller unit shall be provided with labeled terminals for a hand switch.

5. Mounting Panel. A readily accessible mounting panel shall be furnished in each pre-timed controller cabinet, with adequate provisions for terminating all field circuits and for mounting fuses and relays. Each power and direct wire interconnect circuit, except neutrals, shall be fused.

(g) Special Auxiliary Equipment. The following special equipment shall be furnished and installed when required to perform specified functions, when specified in the special provisions or when shown on the plans.

1. Time Switches. Time switches to control system or local flash, dial change, or other specified functions shall be synchronous motor driven; shall be equipped with ten (10) hour spring wound reserve carryover; shall be equipped with an omitting device; and shall provide for at least three (3) openings and three (3) closings per twenty-four (24) hour period. Mechanical and electrical characteristics shall be equal to those specified in subsection 623.02.30C, "Mechanism for Pre-timed Controller Units."

2. Railroad Pre-emption. Railroad pre-emption relays, when required, shall perform the operations provided in subsection 623.02.20, "Railroad Pre-emption."

3. Telephone Relays. Telephone relays shall conform to the provisions in subsection 623.02.25(6), "Telephone Relays."

4. Toggle Switches. Toggle switches shall conform to the provisions in subsection 623.02.25(8) "Toggle Switches."

5. Cartridge Fuses. Cartridge fuses shall conform to the provisions in subsection 623.02.25(10), "Cartridge Fuses."

6. Circuit Breakers. Circuit breakers shall be as specified for service switches under subsection 623.02.11, "Service."

7. Interconnect Isolation Relay Units. Interconnect isolation relay units shall conform to the provisions under subsection 623.02.25(12), "Interconnect Isolation Relay Unit."

(h) Pedestrian Signal Sequence. The controller unit shall provide the following sequence of operations for pedestrian signals:

Steady "WALK" interval.

Flashing "DON'T WALK" clearance interval.

Steady "DON'T WALK" interval.

On pedestrian signal installations where pre-timed controller units are used, flashing "DON'T WALK" indication shall occur during the pedestrian clearance interval and shall continue until the beginning of the vehicle yellow interval.

Flashing "DON'T WALK" indication shall be accomplished by the light cam assembly and a separate flasher. The flasher shall conform to the provisions in subsection 623.02.25C(a), "Flasher and Flasher Relay."

(i) Pre-Timed Controller Cabinet. Each pre-timed controller unit and auxiliary equipment shall be enclosed in a weatherproof metal cabinet.

The cabinet shall be fitted with a master-keyed, police lock and shall be mounted on a pedestal, as shown on the plans. Two (2) keys with shanks at least one and three-fourths (1¾) inches long shall be furnished for each cabinet.

The cabinet shall be fitted with a slip-fitter attachment to permit post-top mounting as shown on the plans.

One (1) screened, raintight vent, one and one-half (1½) inches in diameter, or larger, shall be installed in the top of the controller cabinet; eight (8) screened, raintight vent holes one-half (½) inch in diameter, or larger, shall be provided in the lower backside or bottom of the controller cabinet.

Each controller cabinet door which is twenty-two (22) inches, or larger, in width or six (6) square feet, or larger, in area shall be provided with a stop to limit door opening to ninety (90) and one hundred eighty (180) degrees plus or minus ten (10) degrees. The stop shall be provided with a catch which can be operated when the door reaches the extreme open position and will hold the door open securely until released.

623.02.31 Blank.

623.02.32 Blank.

TRAFFIC SIGNALS AND APPURTENANCES

623.02.33 Signal Faces. Each signal face shall be of the adjustable, colored light, vertical type with the number and type of sections as specified herein or as shown on the plans; shall provide an indication in one (1) direction only; shall be adjustable through three hundred sixty (360) degrees about a vertical axis; and shall be mounted at the location and in the manner shown on the plans.

Unless otherwise shown on the plans, all vehicle signal faces shall contain three (3) sections arranged: red—top, yellow—center, green—bottom.

Pedestrian signals shall be the "WALK—DON'T WALK" type as specified in subsection 623.02.39, "Pedestrian Signals."

All new vehicular signal faces installed at any one (1) intersection shall be of the same make and type.

All new pedestrian signal faces installed at any one (1) intersection shall be of the same make and type.

Vehicle and pedestrian signal mountings shall be oriented so as to provide maximum horizontal clearance to the adjacent roadway.

(a) Optical Units. Each optical unit shall consist of a lens, a reflector, a lampholder, and a clear traffic signal lamp, visible to the traffic to be controlled.

Lenses shall be made of either glass or ultra-violet stabilized poly carbonate plastic conforming to the requirements of ASTM Designation D2473. Plastic lenses shall not distort due to heat from the highest wattage lamp required. Lamps shall be in conformance with the Institute of Transportation Engineers Standards of Traffic Signal Lamps.

Candlepower distribution shall conform to ANSI Standard D–10.1.

All mast arm mounted signal faces shall be provided with twelve (12) inch sections.

A twelve (12) inch section with crosshatched lens shall be provided for all green arrow signal indications. Configuration of the arrows shall conform to the dimensions shown on the plans.

Reflectors shall be made of silvered glass or of specular aluminum with an anodic coating. All reflectors shall conform to ANSI Standard D–10.1.

Lampholders shall conform to the provisions in ANSI Standard D–10.1.

Each reflector, lens, and hood shall be designed in such a manner as to reduce sun-phantom to a minimum.

Lamps for the eight (8) inch units shall be sixty-nine (69) watt maximum, five hundred fifty (550) minimum initial lumens, clear, eight thousand (8,000) hour life, two and seven-sixteenths ($2^{7}/_{16}$) inch Light Center Length (L.C.L.), one hundred twenty (120) volt traffic signal lamps.

Lamps for the twelve (12) inch units shall be one hundred fifty (150) watt maximum, one thousand six hundred fifty (1,650) minimum initial lumens, clear, eight thousand (8,000) hour life, three (3) inch Light Center Length (L.C.L.), one hundred twenty (120) volt traffic signal lamps.

The lamp shall be positioned in the lamp holder to provide lamp filament orientation with the open portion of the filament facing upward or as recommended by the manufacturer of the lamps.

(b) Housing. The signal face housing, or case, shall consist of an assembly of separate interchangeable sections, expansible type for vertical mounting without tie rods, substantially secured together in a watertight manner to form a unit. Each section shall house an individual optical unit.

Each section shall be complete with a one (1) piece, hinged door mounting for the lens and other parts of the optical system, water-tight gaskets, and a simple door-locking device. The optical system shall be so mounted that the various parts may be swung open for ready access or removal. The sections shall be interchangeable and so constructed that sections can be removed or

added. There shall be a round opening in the top and bottom of each head to receive one-half (1/2) inch supporting pipe frame. All parts of the housing, including the doors and end plates, shall be of die cast aluminum conforming to the specifications of ASTM Designation B85, and all parts shall be clean, smooth and free from flaws, cracks, blow holes, or other imperfections.

All exposed bolts, screws, hinge pins, and door-locking devices shall be stainless steel. All interior screws and fittings shall be stainless steel or approved nonferrous, corrosion-resistant material.

All gaskets, including door, lens, and reflector gaskets, but not including lampholder gaskets, shall be of neoprene. Lampholder gaskets shall be of material not affected by heat. The lampholder gasket will not be required when the lampholder is not in direct contact with the glass reflector.

All lampholders shall be so wired that a white wire will be connected to shell of the lampholder and a black or colored wire to the bottom or end terminal of the lampholder. These wires shall, in turn, be connected to the terminal block mounted inside at the back of the housing. The terminal block shall have sufficient screw type terminals so as to terminate all field wires and lamp wires independently, with separate screws. The terminals to which field wires are attached shall be permanently identified or wiring shall be color coded to facilitate field work.

Lampholder wires shall be No. 18 AWG, or larger, six hundred (600) volt, appliance wiring material (AWM), with two sixty-fourths (2/64) inch thermoplastic insulation rated one hundred five (105) degrees Centigrade or with insulation that conforms to Military Specification MIL W-16878D, Type B, with vinyl nylon jacket rated one hundred fifteen (115) degrees Centigrade.

The manufacturer's name or trademark, wire size, insulation type-letter designation and temperature rating shall be marked on the insulation or a Certificate of Compliance conforming to the provisions in subsection 106.05, "Certificates of Compliance," shall be submitted by the manufacturer with each shipment of traffic signal head units.

Each lens shall be provided with a removable hood, five one-hundredths (0.05) inch thick, of sheet aluminum of the full circle type completely closed, except at the ends. Hoods for eight (8) inch section shall be seven (7) inches minimum length and for twelve (12) inch section shall be nine and one-half (9 1/2) inches minimum length unless otherwise shown on the plans. Hoods shall have a minimum downward tilt of three and one-half (3 1/2) degrees.

Each signal section shall be constructed in such a manner that structural failure of the housing will not occur with a wind load pressure of twenty-five (25) pounds per square foot on the projected area of the complete signal face housing, including back plate and hoods.

623.02.34 Directional Louvers. Where shown on the plans, louvers shall be furnished and installed in signal hoods. Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder shall be constructed of No. 22 U.S. gage sheet steel and the vanes shall be constructed of No. 27 U.S. gage sheet steel or the cylinder and vanes shall be constructed of 3003 H14 aluminum alloy of similar construction. Thickness dimensions and arrangements of vanes shall be as shown on the plans.

623.02.35 Back Plates. Back plates shall be constructed of 3003 H14 aluminum alloy sheet fifty-one one-thousandths (0.051) inch minimum thickness, and of the dimensions shown on the plans.

Where a back plate consists of two (2) or more sections, the sections shall be fastened with rivets or with aluminum bolts, peened after assembly to prevent loosening.

All mast arm mounted, bracket mounted, and post top signal heads and all programmed visibility signal heads shall be provided with back plates.

623.02.36 Signal Head Mounting. Bracket mounted signal heads, as shown on the plans, shall be supported by mounting brackets consisting of watertight assemblies of one and one-half (1½) inch standard steel pipe and malleable iron, ductile iron, or brass pipe fittings. All members shall be either plumb or level, symmetrically arranged, and securely assembled. Construction shall be such that all conductors are concealed within the assembly.

The dimensions of mounting brackets between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed eleven (11) inches, except where required to provide proper signal head alignment or directed by the Engineer.

At each signal location, unless otherwise shown on the plans, a terminal compartment shall be constructed into the mounting brackets. Each compartment shall be fitted with a terminal block containing twelve (12) poles, each with two (2) screw type terminals. Each terminal shall accommodate at least five (5) No. 14 AWG conductors. A raintight cover shall be provided, giving ready access to the terminal block. The terminal compartment shall be bronze of sufficient strength to remain intact in the event the pole is knocked down. Slip-fitters, where used without integral terminal compartment, shall be of cast-iron or bronze.

For post-top mounting of bracket mounted signals, the terminal compartment shall be cast with an integral slip-fitter. For post-top mounting of a one (1) way signal head, a slip-fitter without a terminal compartment may be used. Slip-fitter shall fit over a four (4) inch standard pipe or four and one-half (4½) inch outside diameter end of tapered standard. Each slip-fitter shall be provided with two (2) rows of steel set screws, with three (3) screws in each row to secure the assembly in plumb position. Set screws shall be cadmium plated.

Where signal heads are side mounted on poles, the terminal compartment shall be designed to bolt securely to the pole.

Signal heads shall be equipped with positive brass lock rings and fittings designed to prevent heads from turning due to external forces. Lock ring and connecting fittings shall have serrated contacts as shown on the plans.

Signal head assembly for suspension from mast arm shall be equipped with a slip-fitter as shown on the plans.

Signal heads shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal heads may be mounted if the faces are not directed toward traffic or if the faces are covered.

623.02.37 Vehicle Detectors. All vehicle detectors shall be the "inductive loop" type.

(a) General. The term "inductive loop detector" applies to a complete installation consisting of a conductor loop or group of loops installed in the roadway, as shown on the plans, lead-in cable and a sensor unit with power supply installed in a traffic signal controller or traffic count station cabinet.

The sensor (amplifier) unit shall be an electronic device capable of providing closure of an output circuit when a vehicle stands or passes over a loop or one (1) of several loops connected to the input circuitry of the sensor unit.

(b) Performance Characteristics. Sensor units shall provide an output closure for each vehicle passing through the response area of the loop at speeds up to seventy-five (75) miles per hour and shall also provide an output closure of at least three (3) minutes duration when a vehicle is occupying the response area of the loop.

(c) Sensor Unit Construction. Each sensor unit shall be housed in a metal case. Sensor units may be furnished with either an integral power supply or a separate power supply common to more than one (1) sensor unit.

Sensor units to be installed in a common cabinet shall have a frequency difference and shall not interfere with the operation of other sensor units installed in the same cabinet.

In multiple loop installations, all loop conductors to be connected to the same sensor unit shall be wound in the same direction. No more than four (4) loops shall be connected to a single sensor unit.

All input and output circuits for each unit with an integral power supply shall enter via a single connector, type and circuitry for which shall be as shown in the following table. Each connector for modular-type units shall be provided with either threaded shell or spring-loaded latch locking.

Connector Circuitry For Inductive Loop Detector Sensor Units

MS Connector Circuit	Inductive Loop Type 18–1 Pin
120-volt (AC Line)	C
120-volt (AC Neutral)	A
Chassis Ground	H
Loop	D
Loop	E
Relay Contact Common	B
Relay Contact	F
Relay Contact	G
Spare	I, J

All pilot lights and meters shall be mounted on the front panel of the sensor unit or the sensor power source assembly. Input power shall be fused.

Capacitors or inductors necessary for loop tuning shall not be mounted external to the loop detector sensor unit.

The units shall not be affected by transient voltages or voltage variations of plus or minus ten (10) percent.

Each sensor unit shall have a fail safe feature that provides a continuous call when the loop is either open or shorted out.

After a power interruption the units shall return to normal operation within five (5) minutes.

A separate sensor unit, control unit, or amplifier shall be provided for each direction of travel and for each left turn lane.

Each unit shall be provided with a light or meter to indicate when the detector is ready to detect vehicles.

Each detector shall operate over the voltage range specified in subsection 623.02.22, "Operating Voltage."

Circuitry shall be solid-state except for output relays.

Output relays, if used, shall be normally closed.

Units shall be designed to provide ease of maintenance with easily accessible electronic components.

Each detector shall provide positive vehicle detection without readjustment from zero (0) degrees Fahrenheit to one hundred sixty (160) degrees Fahrenheit.

Units shall use printed circuit boards designed to facilitate identification of components. This shall be done by either part identification markings or by providing a pictorial diagram showing physical location and identification of each component. Each printed circuit board shall have the following minimum quality requirements: NEMA Grade G–10 glass cloth base epoxy resin board, one-sixteenth (1/16) inch minimum thickness, organic solder masking and gold plated contacts. Intercomponent wiring shall be copper track with a minimum of two (2) ounces weight per square foot. Printed circuit design shall be such that components may be removed and replaced without permanent damage to boards or tracks.

Sensor unit amplifiers shall conform to the following:

1. Type I Loop Amplifier:

a. The sensor unit shall be designed with one (1) sensor in one (1) frame to control one (1) loop system.

b. The unit shall have a switch frequency separation when used on identical loops.

c. The unit shall have a tuning switch or knob. The switch shall provide for resetting the unit and have an operation position.

d. The unit shall have a sensitivity switch which may be used to minimize calls for adjacent lane vehicles.

e. The sensor unit shall be digital in its timing modes.

2. Type II Loop Amplifier:

a. The senor unit shall be two (2) channel, shelf mounted.

b. Two (2) channel units shall have two (2) MS connectors, one (1) for each channel, wired in accordance with subsection 623.20.25 of these specifications.

c. The unit shall have internal circuitry to prevent cross talk or spurious signals induced between the loops it controls.

d. The unit shall have switches for frequency selection between units.

3. Type III Loop Amplifier:

a. The unit shall have circuitry and controls for individual selection of delay or extension timing on each channel. Delay timing shall be adjustable from zero (0) to thirty-one (31) seconds in one (1) second increments. Extension timing shall be adjustable from zero (0) to seven and five-tenths (7.5) seconds in five-tenths (0.5) second increments. All controls shall be on the outside of the unit.

b. Pins "I" and "J" on the MS connectors shall be used to provide control of delay and extension timing by external devices.

c. All advance detectors shall be provided with Type III loop amplifiers.

d. The Contractor may supply single unit loop amplifiers in lieu of multichannel amplifiers if all other functions of this subsection are met.

e. The sensor unit shall operate with both channels connected to one (1) loop in the extension timing mode.

4. Type IV Loop Amplifiers:

a. The sensor unit shall be a four (4) channel device, shelf mounted.

b. The unit shall have internal circuitry to prevent cross talk or spurious signals induced between all loops it controls.

c. The unit shall have switches for frequency selection between units.

(d) Construction Materials.

1. The conductor for each inductive detector loop shall be continuous, unspliced, Type XHHW-USE, No. 12 AWG neoprene jacketed, seven (7) strand, copper wire.

All lengths of loop wires that are not imbedded in the pavement shall be twisted with at least two (2) turns per foot between roadway and pullbox. Splicing between loop wire and detector cable in the pullbox shall be done in a manner satisfactory to the Engineer.

Where detector lead-in cables are spliced or are spliced to loop conductors or magnetometer detector leads, the splices shall be soldered by the hot iron, pouring, or dipping method. Open flame soldering will not be permitted. Conductors shall be joined by the use of UL listed pressure connectors or other methods permitted by the Engineer. Splices shall be insulated by one (1) of the following methods:

a. Thermosetting Epoxy Compound. A two (2) part liquid thermosetting self-curing epoxy resin, where the two (2) parts are mixed just prior to use, shall be poured into molds of dimensions suitable for the splice.

b. Thermosetting Polyurethane Compound. A two (2) part liquid thermosetting self-curing polyurethane resin, where the two (2) parts are mixed just prior to use, shall be poured into molds of dimensions suitable for the splice.

c. Handcrafted Insulation. Handcrafted insulation shall consist of the following steps:

(1) Completely cover the splice with an electrical insulating coating and allow to dry.

(2) Apply one (1) layer of high voltage tape half-lapped. High voltage tape shall be self-fusing, designed for use on rubber, synthetic, or plastic insulation and shall have a minimum thickness of twenty-six (26) mils.

(3) Apply electrical insulating coating and allow to dry.

(4) Apply one (1) layer of PVC tape, half-lapped.

(5) Apply electrical insulating coating and allow to dry.

(6) Loop detector lead-in cable, from the pullbox adjacent to the loop to the field terminals in the cabinet, shall consist of two (2) No. 12 AWG solid copper conductors with each conductor insulated with three one-hundredths (0.03) inch minimum, high molecular weight, heat-stabilized, colored polyethylene, conforming to the requirements of ASTM Designation D1248, Type

I, Class B, Grade 4. The conductors shall be twisted together with approximately two (2) turns per foot. Nonhygroscopic fillers shall be used to form a firm compact cylindrical core. A nonhygroscopic core tape shall be applied spirally over the core. The cable shall be provided with an outer jacket consisting of extruded, black, polyvinyl chloride conforming to ASTM Designation D1047. The cable shall conform to the International Municipal Signal Association's Specification 19–2.

(7) The loop detector lead-in, from the field terminals in the cabinet to the sensor unit, shall conform to one (1) of the following:

(a) A twisted pair of No. 22 AWG, or larger, conductors conforming to the requirements for cabinet wiring.

(b) A cable containing two (2) No. 22 AWG, or larger, copper conductors with each conductor insulated with fourteen one-thousandths (0.014) inch minimum polyethylene or polypropylene. The conductors shall be twisted and the twisted-pair shall be protected with a shield of tinned copper-brass or aluminum-polyester. The shield shall be grounded at one (1) end of the cable. The cable shall be provided with a chrome vinyl outer jacket with a minimum thickness of twenty-seven one-thousandths (0.027) inch.

Splices in the cable may be made in pull boxes only. All splices in the lead-in cable shall be soldered.

(e) Installation Details. Installation and tests shall conform to the details and notes shown on the plans.

Unless shown otherwise each loop shall consist of three (3) turns of conductor as specified in subsection 623.02.37(b)4, "Construction Materials."

Slots cut in the pavement shall be blown out and dried before installing inductive loop detectors. All sharp edges and ninety (90) degree corners should be chipped off. In addition to the required tests, the Contractor shall check each detector loop prior to filling slot with epoxy or sealant as follows:

1. Each loop shall be tested for continuity.
2. Insulation test for each loop to ground shall not read less than ten (10) megohms to infinity, using a megger.

The slots shall be filled with epoxy sealant to within one-eighth (1/8) inch of the pavement surface. The sealant shall be at least one-half (1/2) inch thick above the top conductor in the saw cut. Before setting, surplus sealant shall be removed from the adjacent road surfaces without the use of solvents. The epoxy sealant shall conform to the requirements of subsection 728.03.09, "Epoxy Sealant for Inductive Loops."

Conductors of all loops to be operated by each sensor unit shall be run continuous to the nearest pull box. The loops shall be joined in the pull box in combination of series and parallel so that optimum sensitivity is obtained at the sensor unit. Final splices between loops and lead-in cable shall not be made until the operation of the loops under actual traffic conditions is approved by the Engineer.

All loop conductors for each direction of travel for the same phase of a traffic signal system, in the same pull box, shall be spliced to a cable which shall be run from the pull box adjacent to the loop detector to a sensor unit mounted in the controller cabinet.

All loop conductors for traffic counters shall terminate in a pull box or on a terminal strip in the traffic count station cabinet when such a cabinet is installed.

Conductors for inductive loop traffic signal and traffic counting installations shall be identified and banded, in pairs, by lane, in the pull box adjacent to the loops and near the termination of the conductors in the controller or traffic count station cabinet. Bands shall conform to the provisions in subsection 623.02.09, "Wiring."

The loop detector conductors shall be installed prior to placing the final surface course on new paving projects. The conductors shall be installed, as shown on the plans, in the compacted layer of asphalt concrete immediately below the uppermost layer.

Sensor units shall not be provided for inductive loop traffic counting installations.

(f) Raising or Relocating Existing Pressure-Sensitive Detectors. Raising existing pressure-sensitive detectors to grade shall be accomplished by removing the existing concrete from the detector frame and filling with Class A concrete around the frame at the new grade, unless otherwise specified.

When detectors are to be relocated, either the existing detector contact unit shall be installed in a new frame and foundation, or the existing frame, if in good condition as determined by the Engineer, may be set in a new foundation. The hole left by removing the detector frame and foundation shall be filled with Class C concrete, except the roadway surface shall be reconstructed with material to match existing surfacing.

623.02.38 Pedestrian Push Buttons. Where shown on the plans, pedestrian push buttons of substantial tamper-proof construction shall be furnished and installed.

The assembly shall be weatherproof and so constructed that it will be impossible to receive any electrical shock under any weather conditions.

The pedestrian push button switch shall be a phenolic enclosed precision snap-acting type, switching unit, single-pole, double-throw, with screw type terminals, rated fifteen (15) amperes at one hundred twenty-five (125) volts, AC, and shall have the following characteristics:

Switching unit shall have a stainless steel plunger actuator and shall be provided with U-frame to permit recessed mounting in push button housing.

Switch shall have an operating force of nine (9) to thirteen (13) ounces and a minimum release force of four (4) ounces.

Pretravel shall be one sixty-fourth (1/64) inch maximum.

Overtravel shall be seven thirty-seconds (7/32) inch minimum.

Differential travel shall be four ten-thousandths (0.0004) to two one-thousandths (0.002) inch.

Where a pedestrian push button is attached to a pole, the housing shall be shaped to fit the curvature of the pole and secured to provide a rigid installation. Saddles shall be provided to make a neat fit when required.

Where a pedestrian push button is to be mounted on top of a two and one-half (2 1/2) inch diameter post, the housing shall be provided with a slip-fitter fitting and screws for securing rigidly to the post.

Push button and sign shall be installed on the crosswalk side of the pole.

Arrows on push button signs shall point in the same direction as the corresponding crosswalk.

623.02.39 Pedestrian Signals. Pedestrian signals shall conform to the following:

(a) Messages. Messages shall be lunar white "WALK" and Portland orange "DON'T WALK" or "hand/man" symbols as defined in the Manual on Uniform Traffic Control Devices.

(b) Types. Pedestrian signal ("WALK, DON'T WALK" or "hand/man" symbols) shall be a one (1) piece jack mounted plug-in plastic module in which the formed neon words and grid neon tubing are integrally molded and positively positioned with relation to the internally screened message plate. The molded polycarbonate module shall plug in for operation without requiring tools or additional wiring. The letter height shall be five and one-half (5 1/2) inches. The letters shall have a stroke width of five-eighths (5/8) inch.

Each signal shall be provided with an "egg crate type" visor designed to eliminate sun phantom.

(c) Housing. The housing shall be made of cast aluminum or 3003 H14 sheet aluminum alloy with finish on both sides, and shall be one-eighth (1/8) inch thick minimum at the points of support.

The housing for pedestrian signals shall be dustproof, weatherproof, and corrosion resistant and shall provide for easy access to, and replacement of, all components.

The housing shall be suitable for either post-top or bracket mounting.

(d) Hoods. The hood shall be of material similar to the housing. The top of the hood shall extend a minimum length of six (6) inches at the top and five (5) inches at the bottom when measured from the surface of the lens. The front shall be normal to the top.

A full divider strip shall be provided between the "DON'T" and the "WALK" indications.

(e) Transformers. Transformers shall be of the proper size for the length of tubing and shall carry the label of UL or Electrical Testing Laboratories.

A separate transformer shall be provided for each of the "DON'T WALK" and the "WALK" indications.

The orange works "DON'T" and "WALK" shall operate from a single transformer.

Transformers shall have a power-factor of ninety (90) percent and shall provide twenty-seven (27) milliamperes minimum current.

Solid state neon types with "hand/man" symbols may be furnished in lieu of transformer types unless otherwise indicated on the plans or in the special provisions.

(f) Conductors. High-voltage wiring between the gas tubes and the secondary side of the transformer shall be made with Gas Tube Sign and Oil Burner Ignition Cable, Type GTO–15 labeled by UL.

Other conductors shall be No. 14 AWG, or larger, with two sixty-fourths (2/64) inch minimum Type TW insulation.

(g) Switch. A fused switch consisting of two (2) cartridge fuses and a

lever for disconnecting the fuses for pedestrian signals shall be mounted within the signal housing and shall be connected to deenergize the transformer primary circuit.

(h) Relays. All relays for operation of the "WALK–DON'T WALK" signals shall be placed in the controller cabinet.

(i) Fasteners. All the machine screws, studs, and washers shall be either plated brass, stainless steel, or other corrosion resistant material.

(j) Gaskets. Gaskets shall be provided as required to make the unit rain-tight and dust-tight.

(k) Finish. The outside of the housing and hood shall be painted in accordance with the provisions in Section 614, "Painting."

(l) Terminal Block. A terminal block as specified in subsection 623.02.33(b), "Housing," shall be mounted in the unit for field wiring.

623.02.40 Programmed Visibility Traffic Signal Heads. Programmed visibility traffic signal heads and the installation thereof shall conform to the provisions in subsections 623.02.33, "Signal Faces," and 623.02.36, "Signal Head Mounting," except the provisions in subsection 623.02.33(a), "Optical Units," and the eighth paragraph in subsection 623.02.33(b), "Housing," shall not apply.

The visibility of the signal indication shall be adjustable within the signal head to fit the lane or lanes in which traffic is to be controlled.

External illumination shall not cause a signal indication nor shall a signal indication in one (1) signal head cause a signal indication in another signal head.

Each section of a signal face shall provide a twelve (12) inch diameter, round indication.

Each section shall be provided with a sun visor.

The indication of each signal head, when unprogrammed, shall be visible from anywhere within fifteen (15) degrees of the optical axis. The signal head shall be capable of being preset at angles between nine (9) degrees above and nine (9) degrees below the horizontal and shall be preset at five (5) degrees below the horizontal, unless otherwise specified.

The signal head with the yellow indication, prior to programming, shall provide a minimum candlepower of two thousand five hundred (2,500) in the direction of the axis and a maximum candlepower of one hundred (100) at fifteen (15) degrees horizontally in each direction from the axis. Said signal head with yellow indication shall be capable of being programmed so that a minimum candlepower of two thousand five hundred (2,500) can be directed along the optical axis and a candlepower of less than one hundred (100) directed at one-half (½) degree horizontal from the axis and no measurable light is directed from one (1) degree to fifteen (15) degrees horizontal from the axis. Under the same conditions, the candlepower of the red indication shall be at least nineteen (19) percent of the yellow indication and the candlepower of the green indication shall be at least thirty-eight (38) percent of the yellow indication.

Lamps for the signal units shall be one hundred fifty (150) watt, one hundred twenty (120) volt, incandescent lamps with a minimum average rated life of six thousand (6,000) hours.

During daylight, the signal indications shall be visible only in those areas or lanes designated. During dusk and darkness, a faint glow visible to the side will be permissible.

Dimming devices shall be provided to gradually reduce the candlepower of each signal head for nighttime operation to approximately fifteen (15) percent of that for daytime operation.

The Contractor shall program the head as provided by the manufacturer and as directed by the Engineer.

623.02.41 The R10–5a(s) sign for mast arm as shown on the plans (left turn on green arrow only) shall be furnished and installed as indicated on the plans and as directed by the Engineer.

623.02.42 The protective/permissive left turn signal heads (cluster type) for mast arms and accompanied five (5) section bracket mounted heads shall be furnished and installed as indicated on the plans and as directed by the Engineer.

The R10–5d(s) "Left Turn Yield on Green (Solid Ball Symbol)" sign shall be furnished and installed unless otherwise indicated on the plans.

LIGHTING

623.03.00 High-Intensity-Discharge Luminaires. High-intensity-discharge luminaires shall be of the enclosed type with horizontal burning lamp and slip-fitted for horizontal mounting on two (2) inch pipe. Luminaires shall be either a semicutoff or a cutoff type and shall be provided with a high pressure lamp. Semicutoff luminaires shall be provided with a refractor and cutoff luminaires with a flat lens. Check plans for type required and if not indicated, semicutoff types shall be furnished.

Prior to energizing a luminaire, the lamp socket shall be set in the proper location for the required light distribution in accordance with the manufacturer's instructions, and the luminaire shall be leveled.

Each luminaire shall consist of a housing, reflector, terminal strip, refractor or a lens, a lamp socket and lamp, and an integral ballast. Glare shields shall not be required unless indicated on the plans.

All parts of the luminaire shall be fabricated from corrosion-resistant materials.

Each housing shall be fabricated from aluminum by either diecasting or forming. Housings that are painted shall withstand a one thousand (1,000) hour salt spray test as specified in ASTM Designation B117. Glare shields when required shall be fabricated from the same materials as the luminaire.

The reflector may be a separate unit or may be integral with the housing. The reflector surface shall be specular and shall be protected by an electrochemically applied anodized finish. The reflector configuration shall reflect a minimum of light through the arch tube of the lamp.

Each refractor or flat lens shall be mounted in a frame that is hinged to the housing and secured with a spring-loaded automatic latch. The joint between the frame or reflector and the housing shall be gasketed. Each refractor shall be made of heat-resisting glass or polycarbonate material as indicated on the plans. Each flat lens shall be made of heat and impact resistant glass.

Each lamp socket shall be a porcelain enclosed mogul-multiple type. The shell shall contain integral lamp grips to assure electrical contact under conditions of normal vibration. The socket shall be mounted in the luminaire in a manner to permit presetting a variety of specific light distribution patterns. The socket leads shall be welded to the screw shell and spring-loaded center contact. Socket shall be rated for one thousand (1,000) watts and shall withstand a six (6) kilovolt high potential test.

The optical system (reflector, refractor, or flat lens lamp socket and lamp) shall be a sealed chamber with provision for filtered breathing. Breathing shall permit intake and exit of air into or from the chamber as a result of expansion or contraction of air in the chamber due to lamp heat. Filtering shall be accomplished by either a separate filter or a filtering gasket.

Field wires connected to the luminaire shall terminate on a barrier type terminal block secured to the housing. The terminal screws shall be captive and equipped with wire grips for wire up to No. 6. All components shall be prewired to a single strip assuring that field connections are made to clearly identified line terminals.

Each integral ballast shall be as specified in subsection 623.03.13 of these special provisions. Where the components are mounted on a down-opening door, the door shall be hinged and secured separately from the refractor or flat lens frame. The door shall be easily removable and replaceable. It shall be secured to the housing in a manner to prevent accidental opening.

In-line fuse holders shall be provided for all luminaires either in base of pole or in signal controller cabinets.

623.03.01 Mercury Vapor Luminaires. Mercury vapor luminaires shall be horizontal burning type. Unless otherwise specified, light distribution shall be IES Type III.

Luminaires shall be provided for slip-fitter end mounting on two (2) inch mast arms.

Glassware shall be the refractor type with inner or outer prisms.

The refractor shall be mounted in a door frame assembly which shall be hinged to the luminaire at the house side and fastened at the street side by means of an automatic type latch.

The refractor and door frame assembly shall be forced upward at the street side by spring-pressure, against the gasket seat, when in the closed and latched position.

All gaskets shall be composed of a material capable of withstanding the temperature involved and they shall be securely held in place.

All parts of the luminaire shall be manufactured from corrosion-resistant materials.

Unless otherwise specified in the special provisions or shown on the plans lamps shall be hard glass type, four hundred (400) watt, mercury vapor, ANSI Type H33–1CD, on thirty (30) foot mounting height.

Mercury vapor lamps shall have a minimum average rated life of twenty-four thousand (24,000) hours.

When specified, luminaires shall have an integral ballast as provided in subsection 623.03.13, "Ballasts."

Unless otherwise specified in the special provisions or shown on the plans, all mercury vapor luminaires mounted on standards shall be equipped with glare shields as provided in subsection 623.03.02, "Mercury Vapor Luminaires with Glare Shields."

623.03.01A High Pressure Sodium Luminaires. Each high pressure sodium luminaire shall be furnished with a one hundred (100) watt, two hundred fifty (250) watt, four hundred (400) watt, or other wattage high pressure sodium lamp as indicated on the plans.

The light distribution for luminaires shall correspond to the IES type shown on the plans.

The lamp shall be operated at the wattage necessary to produce nine thousand five hundred (9,500) lumens with the one hundred (100) watt lamp, twenty-five thousand five hundred (25,500) lumens with the two hundred fifty (250) watt lamp and fifty thousand (50,000) lumens with the four hundred (400) watt lamp.

623.03.02 Blank.

623.03.03 Blank.

623.03.04 Incandescent Luminaires. Type and style of incandescent luminaires, lamp equipment, and transformers shall be as specified in the special provisions.

All side and end mounted luminaires shall be equipped with a two (2) inch slip-fitter.

All side mounted incandescent luminaires shall be equipped with a porcelain heat barrier bushing, except that for multiple type luminaires, glass sleeving may be used.

623.03.05 Soffit and Wall Luminaires and Lamps. Soffit and wall luminaires shall be of the type or types specified.

Soffit and wall luminaires shall be weatherproof and corrosion resistant. Installation details and minimum light distribution shall be as shown on the plans.

Each flush-mounted soffit luminaire shall consist of a cast metal body, a prismatic refractor mounted in a door frame, a prismatic glass reflector and a socket. The body shall have a continuous anchor ring and shall be provided with four (4) two (2) inch conduit hubs. The door frame assembly shall be hinged, gasketed, and secured to the body by at least three (3) machine screws. The refractor shall be clearly identified as to "street side" and shall be keyed so as to fit into the frame in only one (1) way.

Unless otherwise specified, each flush mounted soffit luminaire shall be furnished with an integral ballast mounted on a bracket so constructed that the light center of the mercury vapor lamp is within one-half (1/2) inch of the light center location for which the luminaire is designed.

Where an existing flush mounted incandescent soffit luminaire is to be modified, the mounting bracket for the lamp socket or for the integral ballast

shall be so designed that the existing tapped holes and machine screws can be utilized for the attachment of the bracket to the fixture body.

Each pendant soffit luminaire shall be enclosed and gasketed, and shall be furnished with aluminum finish, three-fourths (3/4) inch top-tapped head, stepped or fluted reflector, and refractor attached to reflector. The reflector shall have a specular anodized aluminum finish. The refractor shall be made of heat-resistant acrylic plastic or glass. The optical assembly shall be hinged and latched for lamp access and shall be provided with a safety chain.

Each pendant soffit luminaire shall be furnished with an eleven (11) gage minimum thickness, metal box (maximum dimensions of eight (8) inches by nine (9) inches by eleven (11) inches) and such box shall house the ballast for the luminaire. The box shall be provided with a gasketed cover with two (2) captive screws and two (2) chains to prevent dropping. Box shall be hot-dip galvanized.

Each wall-mounted luminaire shall consist of a cast metal body of the dimensions shown on the plans. The lens frame shall be gasketed and shall allow servicing without detachment from the body.

Cast metal bodies made of aluminum, which are to be flush mounted in concrete, shall be given a heavy coat of alkali-resistant bituminous paint on all surfaces to be in contact with concrete. The paint shall conform to Military Specification MIL–P–6883.

Unless otherwise specified, each soffit luminaire and each wall luminaire shall be furnished with a hard glass type, one hundred (100) watt, high pressure sodium vapor lamp, with a minimum average rated life of twenty-four thousand (24,000) hours.

623.03.06 Blank.

623.03.07 Sign Lighting Fixtures—Fluorescent. Each fluorescent sign lighting fixture shall be designed for mounting at the bottom of the sign on an overhead sign structure as shown on the plans. The fixture shall be a fully enclosed type, raintight, dust-tight, corrosion-resistant, with hinged plastic cover.

Painting of fixtures will not be required.

(a) Housing. The shell of the fixture shall be fabricated of sixty-four one-thousandths (0.064) inch minimum thickness, 3003 H14 aluminum alloy sheet with Type 7072 alloy cladding or fabricated of other material which will provide equivalent strength and corrosion resistance.

The maximum dimensions of the fixture housing with cover shall be seventy-four (74) inches long (for seventy-two (72) inch nominal lamps), fifteen and one-half (15 1/2) inches wide and five and one-half (5 1/2) inches high.

All external machine screw parts, lock washers, hinge pins, etc., shall be made of Type 316 stainless steel.

(b) Reflector. The reflector shall be fabricated of two one-hundredths (0.02) inch minimum thickness, 3003 H14 Aluminum alloy sheet with Type 1175 alloy cladding on the reflective side.

The reflector surface shall be mechanically polished prior to anodizing. The

finish process shall be performed before or after fabrication of the reflector and shall include the electrochemical brightening procedure using an acid process. The minimum weight of the protective oxide coating shall be five (5) milligrams per square inch. The coating shall be sealed.

The reflector shall have a specular reflectance of not less than sixty-eight (68) percent when measured at forty-five (45) degree specular angle in accordance with Test Method No. Nev. T541.

Reflectors shall be protected during forming and assembling with secure coverings which shall be removed after the assembly has been completed.

Reflectors shall have hemmed edges for safe handling.

(c) Cover. Cover shall be of acrylic material.

Each plastic cover shall latch easily and securely in place without the use of tools and shall be completely free from any tendency to loosen under high winds and vibration. The cover shall be fitted with nonstretching safety cords, chain safety devices, or equivalent, which shall also serve as stops when the cover is hinged open.

(d) Gaskets. Gaskets between the cover and the fixture housing shall be uniform and even-textured, and shall be square-section polyvinyl chloride formed tube with a pressure-sensitive adhesive on one side.

Gaskets shall be neatly applied to thoroughly degreased, clean surfaces with a suitable heat-resistant adhesive, which will not allow the gaskets to slip at a temperature of one hundred sixty (160) degrees Fahrenheit (continuous).

(e) Lampholders. Lampholders shall be listed by UL for outdoor use, shall be provided with silver coated contacts and waterproofed lead entrance for use with a one thousand five hundred (1,500) milliampere, rapid-start, fluorescent lamp. One (1) lampholder for each lamp shall be of the spring-loaded type. Each lampholder shall be provided with a heat-resistant, circular cross section, partially recessed neoprene ring to seal against the lamp ends and protect electrical contacts from moisture and dirt or other injurious elements.

The distance between the face of the lampholders for each lamp shall be designed to provide a compression of at least one-tenth (0.1) inch on the spring-type lampholder when the lamp is in place. The lamp shall have positive mechanical and electrical contact when the lamp is in place. The socket on the spring-type lampholder shall have sufficient travel to permit installation of the lamp.

Springs for lampholders shall not be a part of the current carrying circuit.

Lampholders shall match lamp requirements and shall not increase cathode filament circuit resistance by more than one one-hundredth (0.01) ohm.

(f) Terminal Blocks. Each field wiring terminal block shall be of the heavy-duty pressure connector type with minimum rating of thirty-five (35) amperes, six hundred (600) volts (RMS sixty (60) Hz), and shall have a phenolic base, marking strip, and corrosion resistant metal parts. Terminal screws shall be no smaller than size 10–32. Marking strips shall have permanent symbols indicating wire color as shown on the plans.

All wiring connections in the fixtures and in the ballast boxes shall be terminated on molded, phenolic, barrier type, terminal blocks rated at fifteen (15) amperes, six hundred (600) volts, and shall have integral type, white

waterproof, marking strips. All current carrying parts of the terminal blocks shall be insulated from the fixture or ballast box with integral plugs or strips to provide an insulating value in excess of the line-to-ground flashover voltage. If the Contractor elects to use sectionalized terminal blocks, each section shall be provided with an integral barrier on each side and shall be capable of rigid mounting and alignment.

(g) Conductors. All conductors within the fixture shall be UL approved appliance wiring material (AWM), stranded copper wire with two sixty-fourths (2/64) inch thermoplastic insulation. Conductors for ballasts shall be No. 16 AWG. Ballast conductors shall be secured with easily removable spring cross straps (not clamped, cabled, or served) on the underside of the chassis.

Conductors between sign switch and fixture terminal blocks shall be No. 14 AWG minimum.

Stranded copper conductors shall be tinned before insertion into pressure connector type terminals. Conductors connected to screw type terminals shall terminate in crimp type ring connectors.

1. Sign Lighting Fixtures (One Hundred Twenty (120) Volt/Two Hundred Forty (240) Volt) Integral Ballast Type. In addition to the requirements in subsection 623.03.07, "Sign Lighting Fixtures—Fluorescent," the following requirements shall also apply:

a. Lamps. Each fixture shall be provided with one F72T12, extra high output, cool white fluorescent lamp with recessed double contact base, designed for use at one thousand five hundred (1,500) milliamperes and which shall meet the requirements of ANSI Standard C78.

b. Fuses. Fuses shall be of the miniature, slow blowing type, with appropriate current and voltage rating.

Fuseholder shall be a panel mounting type with threaded or bayonet type knob which grips fuse tightly for extraction.

c. Ballasts. Ballasts shall be the high power factor type with weatherproof leads for operation of one (1) seventy-two (72) inch rapid start lamp. Ballasts shall be listed by UL for outdoor operation on one hundred ten (110) to one hundred twenty-five (125) or two hundred twenty (220) to two hundred fifty (250) volts, sixty (60) Hz circuits (input voltage shown on the plans). Ballasts shall be rated at one thousand five hundred (1,500) milliamperes for high-beam and eight hundred (800) milliamperes for low-beam operation. Multiple to multiple transformers shall not be used.

623.03.08 Sign Switches. Each sign illumination installation shall be provided with a disconnect switch mounted on the sign standard or structure, as shown on the plans.

Enclosure for the sign switch shall be NEMA Type 3R, shall be galvanized or, at the option of the Contractor, shall be provided with a factory applied rust resistant prime coat and baked enamel finish coat, in lieu of galvanizing, and shall be provided with top hinged cover, hasp for sealing cover, and provisions for locking the handle in the "On" and "Off" positions. Padlocks shall be furnished for all sign switch enclosures.

When specified in the special provisions, a circuit breaker shall be provided in lieu of the above fused switch. Circuit breakers shall conform to the

requirements under subsection 623.02.11, "Service," and the ampacity of the circuit breaker shall conform to the requirements of the Code.

In the event the sign structure is to be painted, the sign switch or circuit breaker enclosure shall be painted the same color as the sign structure on which it is installed.

623.03.09 Flashing Beacons. Where shown on the plans, flashing beacons shall be installed. Each beacon shall consist of a single section traffic signal head, conforming to the provisions in subsection 623.02.33, "Signal Faces," with yellow or red lens as shown on the plans. Mounting of beacons, including span-wire mounting if required, shall be as shown on the plans.

Each flashing beacon control unit shall consist of a switch, ten (10) ampere plug fuse, flasher, and terminal block housed in a single enclosure.

The enclosure shall be NEMA Type 3R, and shall be provided with top hinged cover, dead front panel, and a hasp for sealing cover. Padlocks shall be furnished for all enclosures.

The enclosure shall be provided with factory applied, rust-resistant prime coat and baked enamel finish coat. Two (2) coats of aluminum paint shall be applied as specified in subsection 623.02.16, "Painting." At the option of the Contractor the enclosure may be hot-dip galvanized in lieu of painting.

Switches shall be ten (10) ampere, toggle type, single-pole, two (2) wire, one hundred twenty (120) volt, AC, and shall be mounted at the top and center of the dead front panel.

When shown on the plans or specified in the special provisions, a fifteen (15) ampere circuit breaker, conforming to the provisions in subsection 623.02.11, "Service," shall be installed in lieu of the control switch and ten (10) ampere plug fuse specified above.

The flasher shall be solid-state device of adequate capacity and shall have no contact points or moving parts.

Flashers shall provide fifty (50) to sixty (60) flashes per minute with a forty (40) to sixty (60) percent duty cycle.

Flashers shall provide for two (2) circuit, alternate operation of beacons and shall be furnished with plug-in mounting.

Terminal blocks shall be rated at fifteen (15) amperes, six hundred (600) volts, shall be molded from phenolic material and shall be the barrier type with plated brass screw type terminals and integral type marking strips.

Workmanship and material shall be equal to that of first class electrical instruments.

When flashing beacons are installed adjacent to or in conjunction with a traffic signal system, the flasher control shall be installed in the controller cabinet unless otherwise shown on the plans.

The sign panel to be installed on cantilever flashing beacon shall be mounted using galvanized commercial quality five-sixteenths (5/16) inch diameter hexagonal head bolts and nuts, galvanized flat washers, and lock washers with a fiber washer contacting the face of the sign panel.

623.03.10 Photoelectric Controls. Photoelectric controls, as specified in the special provisions or as shown on the plans, shall be capable of

switching multiple lighting systems directly or of switching series lighting systems through a high voltage controller.

(a) Types. The types of photoelectric controls shall be as follows:

Type I photoelectric control shall consist of a photoelectric unit and a contactor in a single weatherproof housing.

Type II photoelectric control shall consist of a photoelectric unit in a weatherproof housing and a separate contactor located in a traffic signal controller cabinet.

Type III photoelectric control shall consist of a photoelectric unit and a separate contactor, each in a separate weatherproof housing.

Type IV photoelectric control shall consist of a photoelectric unit in a weatherproof housing which plugs into an EEI–NEMA twist lock receptacle integral with the luminaire.

A switch to permit manual operation of the lighting circuit shall be provided for each Type I, Type II, and Type III photoelectric control. Switches shall be of the single-hole mounting toggle type, single-pole, single-throw, rated at twelve (12) amperes, one hundred twenty-five (125) volts. Switches shall be furnished with an indicating nameplate reading "Auto-Test" and shall be connected in parallel with the load contacts of the photoelectric unit.

(b) Equipment Details. Equipment details shall conform to the following:

1. Photoelectric Unit. The photoelectric unit shall provide an output in response to changing light levels. The response level shall remain stable throughout the life of the control unit. Components of the unit shall not require periodic replacement.

Units for highway lighting shall have a "turn-on" between one (1) and five (5) foot-candles and a "turn-off" at between one and one-half (1½) and five (5) times "turn-on."

Units for illuminated signs shall have a "turn-on" level of between twenty (20) and thirty (30) foot-candles. (Turn-on level specified above corresponds to a switching level of approximately forty (40) to sixty (60) foot-candles measured in the horizontal plane.) "Turn-off" level shall not exceed three (3) times "turn-on" level.

Measurements shall be by the procedures set forth in EEI–NEMA Standards for Physical and Electrical Interchangeability of Light-Sensitive Control Devices Used in the Control of Roadway Lighting.

Photoelectric controls, except Type IV, shall be furnished with a four (4) inch minimum inside diameter slip-fitter containing a terminal block and with cable supports or clamps to support pole wires.

The photoelectric unit receptacle shall be the EEI–NEMA type. Mounting brackets shall be used where pole-top mounting is not possible. Photoelectric controls shall be installed at the locations shown on the plans and oriented as directed by the Engineer.

For switching four hundred eighty (480) volt, sixty (60) Hz circuits, a one hundred (100) volt-ampere, minimum, four hundred eighty (480) to one hundred twenty (120) volt transformer shall be installed in the contactor enclosure to provide one hundred twenty (120) volts for the photoelectric control unit. Where more than one (1) photoelectric unit is to be installed at the same location, a single transformer, with a volt-ampere rating capable of handling the total controlled load, may be used.

Photoelectric units shall be screened to prevent artificial light from causing cycling.

The photoelectric unit shall also conform to the following:

The supply voltage rating shall be sixty (60) Hz, one hundred five (105) to one hundred thirty (130), two hundred ten (210) to two hundred forty (240), or one hundred five (105) to two hundred forty (240) volts, as required.

The load rating shall be eight hundred (800) watts minimum, incandescent, mercury vapor or fluorescent.

The operating temperature range shall be from minus twenty (20) degrees Fahrenheit to plus one hundred fifty (150) degrees Fahrenheit.

The power consumption shall be less than ten (10) watts.

The base of the unit shall be provided with a three (3) prong, EEI–NEMA standard, twist-lock plug mounting.

2. Contactor. The contactor shall have contacts rated to switch the specified lighting load and shall be normally open, unless otherwise specified.

The contactor shall be the mechanical armature type consisting of an operating coil, a laminated core, a laminated armature, contacts, and terminals. Contacts shall be fine silver, silver alloy, or superior alternative material.

3. Contactor and Test Switch Housing. For Type I control, the enclosure shall house the test switch only. For Type III control, the contactor and test switch shall be housed in a suitable NEMA Type 3R enclosure. The enclosure shall be provided with a factory applied rust-resistant prime coat and baked enamel finish coat. Two (2) coats of aluminum paint shall be applied as specified in Section 614, "Painting." At the Contractor's option the enclosure may be hot-dip galvanized in lieu of painting. A minimum of two and one-half (2½) inches shall be provided between contactor terminals and end of enclosure for wiring connections. The enclosure shall be mounted on the same standard as the photoelectric unit at a height of approximately six (6) feet above the base.

For Type II control, the test switch shall be housed in the traffic signal controller cabinet with the contactor.

4. Wiring. Conductors between the photoelectric unit and an external contactor shall be No. 12 AWG and shall be run inside the lighting standard, or in conduit, unless otherwise shown on the plans.

623.03.11 Blank.

623.03.12 Transformers. Multiple to multiple and series to multiple transformers shall be of the single-phase, dry type designed for operation of a sixty (60) Hz supply.

(a) Electrical Requirements. Transformer ratings shall be one hundred twenty (120) to four hundred eighty (480) volt, two hundred forty (240) to four hundred eighty (480) volt, or four hundred eighty (480) to one hundred twenty (120) volt for multiple to multiple units and six and six-tenths (6.6) ampere to one hundred eighteen (118) volt or six and six-tenths (6.6) ampere to four hundred eighty (480) volt for series to multiple units or other ratings as shown on the plans.

Secondary four hundred eighty (480) volt windings shall be center tapped and the center tap shall be grounded.

Special taps for high or low voltages will not be required.

Volt-ampere ratings shall be as shown on the plans.

Transformer efficiency shall exceed ninety-five (95) percent for multiple to multiple units and eighty (80) percent for series to multiple units.

Average temperature rise of windings, at full load, shall conform to NEMA requirements for Class A insulation.

Secondary voltage regulation and tolerance shall be plus or minus three (3) percent from half load to full load for multiple to multiple units and plus ten (10) percent (maximum) at no load to plus or minus three (3) percent at full load for series to multiple units.

External leads for multiple to multiple and series to multiple secondary connections shall be Type RHW–USE, No. 10 AWG, rated six hundred (600) volts, AC. Primary conductors for series to multiple transformers shall be rated for use on five thousand (5,000) volt, AC circuits.

Transformer insulation shall be NEMA Class F or better.

Potting compound shall conform to the temperature requirements of NEMA Class A insulation.

Series to multiple transformers shall withstand the application of twelve thousand (12,000) volts (RMS, sixty (60) Hz) from core to primary coil and from coil to coil for a one (1) minute period.

Series to multiple transformer secondaries and multiple to multiple transformers shall withstand the application of two thousand two hundred (2,200) volts (RMS, sixty (60) Hz) from core to coils, and, for multiple units only, from coil to coil for a one (1) minute period.

The above tests shall be made immediately after operation of the transformer at full load for twenty-four (24) hours.

(b) Physical Requirements. Submersible type transformers shall be securely encased in a rugged, corrosion resistant, watertight case and shall withstand a five (5) day test submerged in two (2) feet of salt water (two (2) percent salt by weight) with twelve (12) hour on and off periods. The operating periods shall be at full load.

Submersible units shall be capable of withstanding a shock test as specified in Military Specification MIL–STD–202; Test Method 205; Test Condition C. Mounting for shock test may be by any convenient means.

Proof of performance after the above tests shall be as follows:

1. Continuity in all windings.
2. Insulation test at ninety (90) percent of initial test voltage.
3. There shall be no evidence of physical damage such as cracks.

Each transformer to be installed in a pull box shall be the submersible type and shall be provided with a handle and a hanger as shown on the plans for ballast installation in pull box.

Nonsubmersible transformer units shall be provided with metal half-shell coil protection, shall have moisture resistant, synthetic varnish impregnated windings and shall be suitable for outdoor operation in a raintight enclosure.

Transformer leads shall extend a minimum of twelve (12) inches from the case. Leads of submersible units shall be brought out through one (1) sealed

hub and shall be secured in a manner which will withstand a one hundred (100) pound static pull without loosening or leaking.

623.03.13 Multiple Circuit Ballasts. Each ballast for a high-intensity-discharge lamp shall be designed for the type, characteristics, and wattage of the lamp it is to operate and it shall provide the proper starting and operating waveforms, voltage, and current. Ballasts shall provide reliable lamp starting and operation at ambient temperature down to minus thirty (30) degrees C. for the rated life of the lamp.

Ballasts shall be designed for continuous operation at ambient temperature from minus thirty (30) degrees C. to sixty-five (65) degrees C., and shall have an average design life not less than one hundred thousand (100,000) hours. Ballasts shall be designed to operate continuously for six (6) months without reduction in life, over the specified temperature range, with the lamp operating normally or with the lamp circuit in an open or short-circuited condition.

Integral ballasts shall be tested within the luminaire and shall be rated at the temperature normally found within the luminaire.

Starting aids for ballasts of a given lamp wattage shall be interchangeable between ballasts of the same wattage and manufacturer without adjustment.

A Certificate of Compliance conforming to the provisions in subsection 106.05 of these specifications, "Certificates of Compliance," shall be submitted by the manufacturer with each lot of integral ballast luminaires and with each lot of ballasts designed for use outside of luminaires. The certificate shall state that the lot of ballasts meets, in every respect, the above requirements and the lamp-ballast specifications of the lamp manufacturer.

The input voltage for ballasts shall be as shown on the plans or as specified in the special provisions.

Each integral ballast shall consist of separate components, each of which shall be capable of being easily replaced. A starting aid which is encapsulated will be considered as a single component. Each component shall be provided with screw terminals, NEMA tab connectors, or a single multi-circuit connector. All conductor terminals shall be identified as to the component terminal to which they connect.

Heat-generating components shall be mounted so as to use the portion of the luminaire upon which they are mounted as a heat sink. Capacitors shall be located as far as practicable from heat-generating components or shall be thermally shielded to limit the case temperature to seventy-five (75) degrees C.

Transformers and inductors shall be resin-impregnated for protection against moisture. Capacitors, except those in starting aids, shall be metal cased and hermetically sealed.

Ballasts for luminaires mounted on mast arms, brackets, or lowering assemblies shall be the magnetic regulator or auto-regulator (CWA) type with the primary and secondary windings electrically isolated and shall be located within the luminaire housing. The ballast for each horizontally mounted luminaire shall consist of individual components mounted on the luminaire housing, an assembly of components mounted on a metal plate secured to the housing, or individual components mounted on a down opening door con-

forming to the requirements in subsection 623.03.00, "High-Intensity-Discharge Luminaires."

Ballasts for wall-mounted luminaires shall be the high power factor reactor type and shall be located within the luminaire housing.

Ballasts for soffit luminaires shall be the high power factor reactor type and shall be located within the luminaire housing or, when shown on the plans, in a pull box adjacent to the luminaire.

Ballasts for mercury sign lighting fixtures shall be the high power factor type and shall be located within the sign lighting fixture, unless otherwise shown on the plans or specified in these specifications.

(a) Regulator Type Ballasts. Each regulator type ballast shall, when operated with the appropriate lamp, have the following characteristics and shall maintain the following lamp operation:

1. The power factor shall be not less than ninety (90) percent throughout the life of the lamp at nominal line voltage.

2. Lamp wattage at any lamp voltage from nominal through life shall not vary by more than eighteen (18) percent for plus or minus ten (10) percent input voltage variation.

3. For nominal input voltage and lamp voltage, the ballast design center shall not vary more than seven and one-half (7½) percent from rated lamp watts.

4. The ballast shall be designed so that a capacitance variance of plus or minus six (6) percent will not cause more than a plus or minus eight (8) percent variation in lamp wattage regulation throughout rated lamp life for nominal input voltage.

5. The lamp current crest factor shall not exceed one and eight-tenths (1.8) for input voltage variation of plus or minus ten (10) percent at any lamp voltage from initial through life.

(b) High Power Factor Reactor Type Ballasts. Each high power factor reactor type ballast shall, when operated with the appropriate lamp, have the following characteristics and shall maintain the following lamp operation:

1. The power factor shall be not less than eighty-five (85) percent throughout the life of the lamp at nominal line voltage.

2. Lamp wattage at any lamp voltage from nominal through life shall not vary by more than twenty-five (25) percent for plus or minus five (5) percent input voltage variation.

3. For nominal input voltage and lamp voltage, the ballast design center shall not vary more than seven and one-half (7½) percent from rated lamp watts.

623.03.14 Falsework Lighting. When required by the special provisions, falsework lighting shall be installed where vehicular traffic with or without pedestrian traffic crosses through or under structure falsework.

Illumination shall be provided during the hours from dusk to dawn.

The Contractor shall submit a plan of the proposed lighting installations and shall not commence falsework construction until such plans have been reviewed by the Engineer. A subsequent review shall be made by the Engineer after falsework lights have been placed in operation.

Fixtures for illumination of roadway pavement between entrances and exit

portals shall be provided with an RLM standard dome reflector. The reflector shall have a white porcelain enamel finish on the inside and shall be provided with a steel wire guard.

Fixtures shall be equipped with high-temperature glazed porcelain medium base sockets and six (6) foot conductors for splicing, approved by UL for outdoor use.

Fixtures shall be fully adjustable with bracket and locking screws on a mounting-plate and shall provide mounting directly to a standard metal junction box.

Fixtures for pedestrian passageways shall be porcelain box receptacles mounted on standard metal junction boxes and equipped with wire lamp guards. Porcelain box receptacles shall be rated at six hundred sixty (660) watts, two hundred fifty (250) volts. Wire lamp guards shall be made of No. 10 AWG wire and shall be suitable for general construction work.

Lamps shall be an approved type.

Portal faces of falsework shall be illuminated on the side facing traffic with one hundred fifty (150) watt minimum PAR reflector flood lamps mounted on the structure directly over each vertical support adjacent to the travelled way and over the center of each lane. Each lamp shall be supported approximately sixteen (16) feet above the pavement and approximately six (6) feet in front of the portal face, the exact position to be as directed by the Engineer. In addition to the overhead lighting, each side of each vehicular passageway between portals shall be illuminated by a string of yellow, twenty-five (25) watt lamps spaced at twelve (12) foot intervals and mounted between eight (8) and eight and one-half (8½) feet above the pavement.

Each flood light shall be aimed in such a manner as to preclude glare to oncoming motorists.

The overhead clearance sign mounted on the falsework shall also be illuminated.

For illumination of roadway pavement between entrance and exit portals, a continuous row of fixtures shall be installed over the center of each lane beneath the falsework structure at intervals of not more than fifteen (15) feet, with the end fixtures not further than seven (7) feet inside the portal faces. Mounting height of fixtures over the pavement shall be as directed by the Engineer.

Pedestrian openings, through or under falsework, shall be illuminated with fixtures centered over the passageway at intervals of not more than fifteen (15) feet, with the end fixtures not more than seven (7) feet inside the portal faces. The fixtures shall be mounted between nine and five-tenths (9.5) feet and ten and five-tenths (10.5) feet above the walkway surface.

For roadway pavement and portal face illumination, No. 10 AWG conductors with Type S insulation shall be used. For pedestrian passageways, conductors shall be No. 10 AWG and enclosed in a one-half (½) inch unpainted zinc-coated metallic conduit.

Not less than two (2) branch circuits shall be provided. Pedestrian passageway lights and roadway pavement lights shall be on a minimum of one (1) circuit and portal flood lights shall be on a minimum of one (1) separate circuit. Each branch circuit shall be fused, not to exceed twenty (20) amperes.

The above specified portal lighting shall be installed on the day that

horizontal members are erected and before traffic is permitted to pass under the falsework during the hours from dusk to dawn. The other falsework lights shall be installed as soon as the members on which they are to be supported are in place.

Energy costs for falsework lighting shall be paid by the Contractor.

On each side of each portal entrance, and no farther apart than the least horizontal clearance within the portal, clearance guides consisting of a panel of boards or a plywood sheet, four (4) feet wide by eight (8) feet long, shall be fastened vertically facing traffic with the bottom of the panel three (3) feet to four (4) feet above the roadway. Said clearance guides shall be fastened in place before darkness on the day that vertical supports are erected and shall be maintained clean and white by the Contractor.

Upon completion of the project or when directed by the Engineer, falsework lighting equipment shall become the property of the Contractor and shall be removed from the site of the work.

SALVAGING AND REINSTALLING OR STOCKPILING ELECTRICAL EQUIPMENT

623.03.15 Salvaging Electrical Equipment. Where shown on the plans or ordered by the Engineer, existing electrical equipment to be removed, including controller units, cabinets, signal heads, luminaires, standards, mast arms, ballasts, transformers, service equipment, pull boxes, and detector contact units shall be salvaged for reuse by the maintaining agency.

Care shall be exercised in removing and salvaging electrical equipment so that it will remain in its original form and existing condition whenever possible. Attention is directed to the provisions in subsections 107.11, "Responsibility for Damage Claims," and 107.12, "Protection and Restoration of Property and Landscape." The Contractor will be required to replace, at his expense, any of the above-mentioned electrical equipment, which, as determined by the Engineer, has been damaged or destroyed by reason of his operations.

Unless otherwise specified, underground conduit, conductors, foundations, and detector frames not reused shall become the property of the Contractor and shall be removed from the highway right of way, except if not interfering with other construction, said materials, except foundations, may, with the written approval of the Engineer, be abandoned in place. Certain other materials, when shown on the plans, shall also become the property of the Contractor.

Attention is directed to the provisions in subsection 623.02.02A, "Foundations," regarding foundations to be abandoned.

Holes formed by removing pull boxes and foundations shall be filled with material equivalent to the surrounding material.

623.03.16 Reinstalling Salvaged Electrical Equipment. When salvaged electrical equipment is to be reinstalled, the Contractor shall furnish and install all necessary materials and equipment, including signal mounting brackets, anchor bolts, nuts, washers, and concrete as required to complete the new installation.

All traffic signal, flashing beacon, and lighting fixtures to be reinstalled shall be cleaned and relamped.

Existing materials required to be relocated and found to be unsatisfactory by the Engineer shall be replaced by new material and the cost therefor will be paid for as extra work as provided in subsection 104.03, "Extra Work."

623.03.17 Stockpiling Salvaged Electrical Equipment. Existing equipment removed and not reused shall be salvaged and shall be stockpiled at the site of the work.

METHOD OF MEASUREMENT

623.04.01 Measurement. When a Traffic Signal System, a Highway Lighting System, or a Traffic Signal and Highway Lighting System is bid on a lump sum basis, measurement will be made as a complete system.

When a Traffic Signal System or Highway Lighting System is bid on individual items, measurement will be made by the linear foot, square foot, lump sum, or by the unit furnished and installed in accordance with the contract documents, and making all required tests, as directed by the Engineer and the following methods:

Linear Foot Measurement. Conduit installed complete in place. Conductors, lead-in cable for loop detectors, signal cable, and interconnect cable installed complete in conduit.

Square Foot Measurement. Traffic signal signs installed complete in place.

Each Unit Measurement. Pull boxes, steel poles, luminaires, street name signs, signal heads, pedestrian signal heads, pedestrian push buttons with signs, loop detectors, controllers, electrical service, underpass luminaires, sign lighting fixtures, modify controllers, detector amplifier channels, remove and reset light pole, remove and reset signal pole, remove and reset street name sign, remove and reset signal head, remove and reset luminaire, remove existing signal head and junction boxes installed complete in place.

Lump Sum Measurement. Removal of existing traffic signal systems and removal of existing lighting systems for the work complete as set forth on the plans and these specifications.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

623.05.01 Payment. The lump sum price or prices paid for traffic signals, highway lighting systems, sign illumination systems, or combinations thereof measured as set forth in subsection 623.04.01, "Measurement," shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and installing, modifying, or removing the systems or combinations thereof as shown on the plans as specified herein and as directed by the Engineer, including any necessary pull boxes, excavation and backfill, concrete foundations, restoring sidewalk, pavement, and appurtenances damaged or destroyed

during construction, salvaging existing materials, and making all required tests.

Conduit. The unit price bid per linear foot shall include all excavations, backfill, all cutting, bending, fitting, capping, furnishing and placing pull lines and tags, expansion fittings, hardware, and incidental fittings as required.

Modify Controller. The unit price bid per each shall include all material and labor costs to complete modifications as described on the plans.

Loop Detector Amplifier Channels (existing cabinet). The unit price bid per each shall include the cost of furnishing and installing sensor units in existing cabinets wired to function with local controller as shown on the plans.

Loop Detector Amplifier Channels (new cabinet). The unit price bid each shall include the cost of furnishing and installing sensor units in cabinets wired to function with local controller and traffic control system as shown on plans.

Remove and Reset Signal Head. The contract unit price bid per each shall include removal and relocation of signal head, mounting, incidental fittings, and new lenses when required as noted on plans.

Remove and Reset Luminaire. The contract unit price bid per each shall include removal and relocation of luminaire, wired in and functional as described on the plans.

Remove and Reset Light Pole. The unit price bid shall include removing existing light poles and resetting the poles on a new foundation. The cost of material, labor, and equipment, including the cost of the foundation shall be included in the contract unit price bid per each for "Remove and Reset Light Pole."

Remove and Reset Signal Pole. The unit price bid shall include removing existing signal poles and resetting the poles on a new foundation. The cost of material, labor, and equipment including the cost of the foundation shall be included in the contract unit price bid per each for "Remove and Reset Signal Pole."

Steel Poles. The unit price bid each for the type of pole specified in the contract documents shall include the furnishing of arms and all fittings, safety bases when required, and the necessary anchor bolts, concrete foundation, and reinforcing steel, as well as all structure excavation and backfill required to complete the work.

Electrical Service. The unit price bid each shall include all rigid conduit, enclosures, circuit-breakers, wiring, hardware, panels, meter pedestals or sockets, riser pole, overhead conductors, drops, etc., furnished and installed as shown on the plans.

Controller. The unit price bid each shall include the controller, cabinet, concrete foundation, and incidental items required.

Signal Heads. The unit price bid each shall include the signal head, internal wiring, mounting fittings, hoods, lamps, and incidental fittings as required.

Removing Existing Lighting and/or Signal Systems. The unit lump sum price bid shall include the excavation, concrete, and backfill materials required or specified by the Engineer.

Restoring sidewalks, pavement, and appurtenances damaged or destroyed during construction, salvaging existing material, and making all required tests shall be considered as included in the payment for the individual items and no further payment will be made therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

When a complete system is paid for on a "Lump Sum" basis payment will be made under:

Pay Item	Pay Unit
Traffic Signal System	Lump Sum
Highway Lighting System (may include sign lighting system)	Lump Sum
Traffic Signal and Highway Lighting System (may include sign lighting system)	Lump Sum
Conduit for Future Conductors	Linear Foot

When a signal or lighting system is bid on individual items payment will be made under:

Pay Item	Pay Unit
(size) Conduit	Linear Foot
(size) Pull Boxes	Each
Steel Pole (type)	Each
High Mast Steel Pole	Each
(type) Luminaire (watt)	Each
Underpass Luminaire, 175 Watt (type mount)	Each
Illuminated Street Name Sign (type face)	Each
Sig. Head (12") (type) (mount)	Each
Sig. Head (8") (type) Bracket	Each
Ped. Sig. Head (type)	Each
Ped. Push Button With Sign	Each
Loop Detector (size)	Each
Special Detector Installation	Each
(type) Controller	Each
(type) Electrical Service	Each
Traffic Signal Signs	Square Foot
(size) Conductor	Linear Foot
(size) Conductor (size) Cable	Linear Foot
Lead-in Cable for (type) Detector(s)	Linear Foot
Wood Pole (size)	Each
Special Steel Pole	Each
Span Wire Cable	Linear Foot
Sig. Head (12") (type) Span Wire	Each
Junction Box	Each
Removal of Existing Traffic Signal System	Lump Sum
Removal of Existing Lighting System	Lump Sum
Modify Controller	Each
Loop Detector Amplifier Channels (Existing Cabinet)	Each
Loop Detector Amplifier Channels (New Cabinet)	Each
Removal of Existing Signal Head	Each
Remove and Reset Signal Pole	Each
Remove and Reset Light Pole	Each
Remove and Reset Street Name Sign	Each
Remove and Reset Luminaire	Each

SECTION 624

ACCOMMODATIONS FOR PUBLIC TRAFFIC

DESCRIPTION

624.01.01 General. This work shall consist of providing for traffic by constructing detours, using existing streets and roads as detours permitting traffic to pass through construction, and using flaggers or pilot cars and maintaining the base, or a combination of these methods as indicated in the contract documents or as directed in writing by the Engineer.

MATERIALS

624.02.01 General. The materials used for the construction and maintenance of facilities required for the free flow of public traffic and for protection of the work shall be those prescribed for the several items which constitute the finished work and shall conform to all the requirements for such materials as set forth herein.

CONSTRUCTION

624.03.01 Detours. Detours shall be constructed as shown on the plans or as specified. Detour locations indicated on the plans may be approximate only; the exact location shall be as staked by the Engineer.

Grading for detours shall consist largely of motor grader work, supplemented where necessary by other mechanical equipment, to provide the specified roadbed width and a grade line free from breaks or rolls of sufficient magnitude to be hazardous to traffic.

When grading of detours has been completed and approved by the Engineer and, if required on the plans or in the special provisions, the detours shall receive surfacing materials of the kind and type specified, and they shall be placed and constructed in accordance with the requirements for the particular materials used.

Water shall be applied to detours in amounts necessary to attain the compaction of graded sections and of surfacing materials.

Maintenance of detours shall consist largely of filling holes as they develop, adding surfacing and applying liquid asphalt, blading, watering, and performing any other work necessary to maintain the detour satisfactorily, as ordered by the Engineer.

Eradication of detours shall consist largely of motor grader and scraper work supplemented by other equipment when necessary. Eradication will be performed to the extent that the ground will be restored as nearly as feasible to the original, and material disposed of, all as directed by the Engineer.

624.03.02 Flaggers. If, in the opinion of the Engineer, controlled traffic is necessary for protection of the work or for safety of public traffic, flaggers shall be employed by the Contractor at places designated by the Engineer.

This does not exclude the use of flaggers by the Contractor, at his expense, whenever he sees fit to do so.

Flaggers shall have completed an approved instructional course in flagger procedures. Prospective flaggers shall possess a valid flagger card attesting that they have satisfactorily completed said instructional course conducted by the Department or some other approved course given by another entity of government within the State.

The following requirements shall apply to those persons who attend an approved instructional course in flagger procedures as required in these specifications:

(1) The individual must be a minimum of eighteen (18) years of age.

(2) The individual must be able to speak, read, and write English.

The foregoing requirements shall not apply to those individuals who possess current valid flagger cards provided said card is renewed prior to the expiration date.

The Contractor will be reimbursed for the time required to instruct his employees who are proposed flagger candidates as follows:

(a) Attendance must be to a course of instruction given by the Department.

(b) Employee must be on the Contractor's payroll for the hours of reimbursement.

(c) Reimbursement will be for the actual instruction period required or a maximum of two (2) hours whichever is less.

(d) Reimbursement shall be at the contract unit price bid per hour for flagger and no additional compensation will be allowed therefor.

Each flagger shall be supplied for use in daylight, with an orange vest, orange hard hat, and orange soft cap. When the Contractor or the Engineer designates any area as a hard hat area, hard hats shall be mandatory in those areas. For nighttime conditions, similar outside garments shall be reflectorized.

Flaggers shall use a combination "STOP" and "SLOW" sign paddle conforming to the requirements of this subsection. The paddles shall be a minimum of eighteen (18) inches wide, with six (6) inch series "C" letters and have a rigid fixed handle. This combination sign paddle may be fabricated from sheet metal or other light semirigid material. The background of the "STOP" face shall be red with white letters and border. The background of the "SLOW" face shall be orange with black letters and border.

624.03.03 Pilot Cars. If, in the opinion of the Engineer, it is necessary to afford additional protection to the work, workmen, or public traffic, a pilot car and driver shall be used as he directs. This provision shall be in effect even though the pilot car and driver are not indicated on the plans or provided for in these specifications.

Pilot cars shall be suitable vehicles in good mechanical condition and shall carry a sign which shall comply with the design shown in the "Standard Highway Signs" manual.

624.03.04 Maintain Base. When the proposal contains an item of maintain base, the provisions of subsection 109.03, "Extra and Force Account Work," shall apply.

624.03.05 Equipment Rental. When the proposal contains an item of equipment rental, the use of such equipment shall be as directed by the Engineer or as indicated on the plans.

All equipment rented in accordance with this subsection shall be equipped with buckets, scrapers, and other required accessories that do not exceed the power unit manufacturer's recommended maximum capacity for the particular power unit involved.

The use of the items of rent equipment shall apply to incidental construction where so indicated on the structure list in the plans and as directed by the Engineer, and no additional compensation shall be allowed for such work.

Removal and disposal of bituminous material shall be paid for under the item of "removal of bituminous surface" and no further compensation shall be allowed therefor.

Equipment shall conform to the following minimum requirements:

Motor Grader	115 h.p. Blade Length 12 Feet
Loader	2½ Cubic Yards Capacity
Dump Truck	8 Cubic Yards Struck
Rubber-Tired Tractor with Scraper	290–350 h.p. with Manufacturer's Rated Capacity Scraper (tractor shall be equipped with all necessary accessories to operate scraper)
Tractor-Crawler with Dozer and/or Ripper	Manufacturer's Rated h.p. 250 (tractor shall be equipped with all necessary accessories to operate bulldozer and ripper)
Elevating Scraper	160 h.p.—10 Cubic Yards Struck (fully equipped with all accessories for scraper operations)

All equipment shall be in good operating condition and shall be approved by the Engineer prior to use.

624.03.06 General. Traffic control for material source haul roads shall conform to the details shown on Sheet No. T–35.1.6 or T–35.1.6.1, as the case may be, of the standard plans unless otherwise directed by the Engineer.

The Contractor shall notify police and fire departments having jurisdiction over the project when traffic patterns are to be altered due to construction operations. Such notification shall be in writing with a copy to the Engineer, and except in extreme emergencies, the notice shall be submitted at least twenty-four (24) hours in advance of rerouting public traffic. The notification shall set forth the specific traffic patterns to be provided in lieu of normal routing and the estimated duration of such change(s) together with such additional information which will contribute to the general safety of the public as determined by the Engineer.

Except as hereinafter provided, access to properties abutting the right of way shall be maintained in a manner closely approximating existing access unless otherwise shown on the plans or directed by the Engineer. When access to private driveways must be temporarily denied due to construction operations such as the installation of storm drains, sidewalks, curbs, and gutters, etc., the Contractor shall notify the property owner or responsible party of

such closure not less than twenty-four (24) hours in advance of closure. The notification shall be in writing and shall include the estimated duration of the closure.

When the Contractor's equipment is crossing or using any portion of the travelled way over which public traffic is directed, all debris dropped by his equipment shall be cleaned up and removed at frequent intervals as directed by the Engineer.

METHOD OF MEASUREMENT

624.04.01 Measurement. Measurement for the various items involved in accommodating traffic shall be paid for as follows:

(a) When required, construction, maintenance, and removal of detours shall be measured for payment under appropriate bid items as indicated on the plans, or in the absence of appropriate bid items, measurement shall be on a force account basis in accordance with subsection 109.03, "Extra and Force Account Work."

(b) When the proposal contains an item of "Flagger," flagging shall be provided as set forth in these specifications or ordered by the Engineer or other governmental agency having jurisdiction. Only the hours that authorized flaggers are actually used to direct traffic within the right of way limits of the project or at points where the Contractor's hauling equipment enters and leaves the public traffic stream while hauling from deposits (except commercial sources), within or without the project limits, as approved by the Engineer, will be measured or paid for. The cost of all other required flaggers shall not be measured or paid for directly, but the cost thereof shall be considered as included in the payment for other items of work.

(c) When the proposal contains the item of "Pilot Car," the piloting as specified in the contract documents or ordered by the Engineer, will be measured by the number of hours that the pilot car and driver are actually used to lead traffic through the controlled areas.

(d) When the proposal contains an item "Maintain Base," measurement for payment will be made in accordance with the provisions of subsection 109.03, "Extra and Force Account Work."

(e) When equipment is used for work designated on the plans or directed by the Engineer, and such equipment is rented as indicated in the proposal, it shall be measured for payment by the number of hours actually used.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

624.05.01 Payment. Payment for detours, measured as specified in subsection 624.04.01, "Measurement," will be paid for under appropriate bid items or by force account.

Payment for maintain base, measured as specified in subsection 624.04.01, "Measurement," will be paid for by force account.

The accepted quantities of flaggers measured as specified in subsection 624.04.01, "Measurement," will be paid for at the contract bid price per

hour for flaggers, which price shall be full compensation for all equipment, competent personnel, and all incidentals necessary for the operation.

The accepted quantities of pilot car, measured as specified in subsection 624.04.01, "Measurement," will be paid for at the contract bid price per hour for pilot car, which price shall be full compensation for the vehicle, an experienced driver, all operating costs, and depreciation.

When the items of flaggers or pilot car do not appear in the proposal, and it is necessary to protect the travelling public, in the Engineer's opinion, flaggers or pilot cars will be furnished by the Contractor and payment therefor will be made in accordance with subsection 104.03, "Extra Work," except, however, when the Contractor constructs and maintains a detour at his expense as provided in subsection 104.04(c), "Maintenance of Traffic."

The accepted quantities of equipment rental measured as specified in subsection 624.04.01, "Measurement," will be paid for at the contract unit price bid per hour for the particular items of equipment indicated in the proposal form. The contract unit price bid per hour shall include skilled operators for each piece of equipment, fuel, lubricants, repairs, depreciation, and all expenses incidental to the operation of the equipment.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Detours	Appropriate Bid Items or Force Account
Flagger	Hour
Pilot Car	Hour
Maintain Base	Force Account
Rent Equipment (type)	Hour

SECTION 625

CONSTRUCTION SIGNS

DESCRIPTION

625.01.01 General. This work shall consist of furnishing and erecting for rental all necessary barricades, portable precast concrete barrier rail, drums, vertical panels, traffic cones, delineators, Type A, Type B, and Type C barricade warning lights, and arrow boards and standard construction signs at locations set forth in the contract documents, or as directed by the Engineer, for the protection of the work, workmen, and guidance and safety of the travelling public.

All rented construction signs, barricades, portable precast concrete barrier rail, drums, vertical panels, traffic cones, delineators, barricade warning lights, and arrow boards shall remain the property of the Contractor upon completion of the contract and shall be removed from the project by him.

All signs, barricades, drums, vertical panels, traffic cones, delineators, barricade warning lights, and arrow boards shall conform to the requirements of the MUTCD Manual, the Standard Highway Sign Book, current edition, including the Nevada supplement thereto, unless indicated otherwise on the plans or the special provisions.

Rented portable precast concrete barrier rail shall conform to Sheet No. R–8.3.3 of the standard plans and the applicable requirements of these specifications.

MATERIALS

625.02.01 General. It is expressly intended that a rather broad selection of material be granted the Contractor since construction signs are in temporary use. Sign panels may be constructed of steel, aluminum, wood, or other approved material and be of a sound, durable nature. The materials shall be of such quality to do the job for which they are intended and are subject to approval by the Engineer. Signs which have become dull, have flaking or peeling paint, are dirty, or are otherwise marred shall be repaired or replaced with acceptable signs.

All materials shall conform to the requirements specified in the following section:

Sign Materials.....Section 716

625.02.02 Reflectorization. All construction signs, barricades, and delineators shall be reflectorized. Traffic cones, when used during the hours of darkness, shall be reflectorized. Minimum reflectorization shall be as follows:

(a) Signs shall be reflectorized using Type I reflective sheeting materials.

(b) Barricades, drums, vertical panels, and traffic cones shall be reflectorized so as to be visible under normal atmospheric conditions from a minimum

distance of one thousand (1,000) feet when illuminated by the low beams of standard automobile headlights.

(c) Delineators shall be reflectorized by means of a prismatic reflector with a minimum diameter of three (3) inches.

(d) Portable precast concrete barrier rail shall be reflectorized by placement of a two (2) way reflector in the center of each barrier rail section and located on top of the rail. Color of the reflectors shall conform to the requirements of the MUTCD Manual.

625.02.03 Sign Dimensions. Sign dimensions shown are minimum standard. Increases above this minimum are permissible and desirable where investigation has shown a larger sign is needed for adequate emphasis. In the enlarging of signs, standard shapes and colors shall be used, and standard proportions shall be retained, so far as practicable.

CONSTRUCTION

625.03.01 General. Before any detour or temporary route is opened to traffic, all necessary signs shall be in place. Signs required by road conditions or restrictions shall be removed immediately when those conditions cease to exist or the restrictions are withdrawn. Guide signs directing traffic to and on temporary routes or detours shall be removed when no longer applicable.

625.03.02 Sign Placement. Signs must always be placed in positions where they will convey their messages most effectively without restricting lateral clearance of sight distance. Placement must therefor be accommodated to highway design and alignment. Signs must be so placed that the driver will have sufficient time to absorb the message before having to act.

Signs shall be located in accordance with the MUTCD Manual and the Nevada Work Zone Traffic Control Handbook as approved by the Engineer.

625.03.03 Sign Supports. Signs, posts, and their foundations shall be so constructed as to hold signs rigidly in a proper and permanent position, and prevent them from swaying in the wind, or from being turned or otherwise displaced by children or irresponsible persons.

A portable or removable type of mounting may be used for signs required intermittently or which are frequently moved. Such a mounting shall be heavy enough not to turn over in the wind, and its base shall not be appreciably wider than the sign.

625.03.04 Barricades. Highways closed to traffic shall be protected by Type I, Type II, Type III, or Type IIIB barricades or drums, or portable precast concrete barrier rail, as approved by the Engineer, on which shall be placed appropriate regulatory signs. The Contractor shall provide and maintain appropriate warning and detour signs at all closures, intersections, and along detour routes, directing the traffic around the closed portions of the highway so that the temporary detour route or routes shall be indicated clearly throughout its or their entire length.

For the purpose of subsection 109.06, "Partial Payment," rented portable

precast concrete barrier rail is hereby classified as "barricades" and partial payment shall be made provided the Contractor has submitted adequate certification that materials used to construct portable precast concrete barrier rails conform to these specifications and provided the rail is satisfactory as determined by the Engineer.

Rocks, asphalt or concrete pieces, construction materials, and other debris shall not be used as a weighting device for barricades or drums; however, sand bags will be permitted as long as a low center of gravity is maintained as approved by the Engineer.

METHOD OF MEASUREMENT

625.04.01 Measurement. The quantity of construction signs to be measured for rental will be the number of square feet of sign surface furnished in accordance with the dimensions shown on the plans.

Barricades will be measured for rental and will be identified by the type set forth in the proposal. If more than one (1) type of barricade is involved, separate measurement will be made for each type given. For purposes of measurement and rental, Type I and Type IIIA barricades shall be measured for rental by the linear foot of width of the barricade or barricades erected. Type II and Type IIIB barricades shall be measured for rental as units. Traffic cones, drums, vertical panels, or delineators shall be measured for rental as units. Type A, Type B, and Type C barricade warning lights and arrow boards shall be measured for rental as units.

Rent portable precast concrete barrier rail will be measured for rental on a linear foot basis.

It is intended that rent portable precast barrier rail be measured for payment one (1) time only and that movement to another location will not be grounds for remeasurement. However, should additional lengths be required over and above the length first measured, such additional lengths will be measured for payment.

Only the quantity and type of signs, barricades, portable concrete barrier rail, drums, and vertical panels ordered or approved in writing by the Engineer for delivery to the project will be measured for payment. Such order or approval will not be given until after the Contractor has informed the Engineer of his proposed method of operation.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

625.05.01 Payment. The accepted quantity of construction signs measured as provided in subsection 625.04.01, "Measurement," will be paid for at the contract unit price bid per square foot.

Signs which have been measured for payment as set forth in subsection 625.04.01 but were not erected will be paid for only at the rate of sixty (60) percent of the contract unit price bid.

Payment will not be made for signs which are inadequate or are not in compliance with the specification requirements; therefor, permanent deduc-

tions will be made from the final payment as determined by the schedule of prorating progress set forth in subsection 109.06 of these specifications.

The accepted quantity of barricades measured as provided above will be paid for at the contract unit price bid per linear foot for Type I and Type IIIA barricades and at the contract unit price bid per each for the Type II and Type IIIB barricades and traffic delineators, drums, vertical panels, and cones, and Type A, Type B, and Type C barricade warning lights and arrow boards.

The accepted quantity of portable precast concrete barrier rail measured as provided above will be paid for at the contract unit price bid per linear foot for rent portable precast concrete barrier rail, which price shall be considered full compensation for furnishing and installing reflective pavement markers thereon.

Moving signs, barricades, portable precast concrete barrier rail, arrow boards, drums, vertical panels, cones, and delineators from one location to another on the project, as directed by the Engineer, shall be considered necessary and essential and no additional compensation will be allowed therefor.

The above prices shall be full compensation for furnishing, erecting, maintaining, moving, removing, and disposing of signs, arrow boards, barricades, portable precast concrete barrier rail, drums, vertical panels, cones, and delineators and any necessary excavation and backfill and for furnishing warning lights and hardware necessary to complete the work.

Partial payments may be made as set forth under subsection 109.06, "Partial Payments."

Signs, barricades, portable precast concrete barrier rail, warning lights, arrow boards, drums, vertical panels, cones, and delineators which have been approved for payment shall not be removed from the project until approved in writing by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Rent Construction Signs	Square Foot
Rent Construction Barricades (Type I)	Linear Foot
Rent Construction Barricades (Type IIIA)	Linear Foot
Rent Portable Precast Concrete Barrier Rail	Linear Foot
Rent Construction Barricades (Type II)	Each
Rent Construction Barricades (Type IIIB)	Each
Rent Traffic Delineators	Each
Rent Traffic Cones	Each
Rent Barricade Warning Lights (Type A)	Each
Rent Barricade Warning Lights (Type B)	Each
Rent Barricade Warning Lights (Type C)	Each
Rent Arrow Board (Type A)	Each
Rent Arrow Board (Type B)	Each
Rent Arrow Board (Type C)	Each
Rent Traffic Drums	Each
Rent Vertical Panels	Each

SECTION 626

TEMPORARY SIGNS

DESCRIPTION

626.01.01 General. This work shall consist of furnishing and erecting signs, barricades, traffic cones, delineators, and/or warning lights, or erecting similar traffic control devices previously removed at locations shown in the contract documents or directed by the Engineer, for the safety of the travelling public at temporary connections, crossovers, and/or detours. All signs, barricades, traffic cones, delineators, and warning lights shall be retained by the State as State property.

All signs, barricades, traffic cones, delineators, and/or warning lights shall conform to the requirements of the MUTCD Manual, the Standard Highway Sign Book, current edition, including the Nevada Supplement, unless indicated otherwise on the plans or in the special provisions.

MATERIALS

626.02.01 General. All materials shall be new, except materials which have been designated as reset.

New material shall conform to the following applicable requirements:

Sign Materials.....Section 716

Sign posts shall be timber of the size shown on the plans. The posts shall be of the same materials and receive the same preservative treatment as required under Section 620, "Right of Way Markers."

626.02.02 Reflectorization. All signs, barricades, traffic cones, and delineators shall be reflectorized. The minimum reflectorization shall be as follows:

(a) Signs shall be reflectorized using Type I reflective sheeting unless otherwise specified.

(b) Barricades and traffic cones shall be reflectorized so as to be visible under normal atmospheric conditions from a maximum distance of one thousand (1,000) feet when illuminated by the low beams of standard automobile headlights.

(c) Delineators shall be reflectorized by means of a prismatic reflector with a minimum diameter of three (3) inches.

CONSTRUCTION

626.03.01 General. Signs, barricades, traffic cones, and delineators shall conform to the details shown on the plans.

Before any route is opened to traffic, all necessary signs shall be in place.

626.03.02 Signs. Sign locations indicated on the plans are approximate

only. Final determination of sign locations will be made in the field by the Engineer.

Each sign face shall be thoroughly cleaned according to the reflective material manufacturer's recommendations, and all undesirable material that is visible on the face of the sign shall be removed. The use of abrasives or other cleaning material that will scratch or otherwise deface shall not be permitted.

Sign faces of all directional signs facing public traffic and directing such traffic to a portion of the project not yet open to public traffic shall have the message covered.

Care shall be exercised at all times in handling, storing, transporting, and erecting of the signs. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

626.03.03 Traffic Cones. Temporary traffic cones shall conform to the design and placement shown on the plans. Cones shall be attached to the pavement with an epoxy designed for the purpose of attaching the flexible cone material to the type of pavement at the location shown on the plans. The rate of application of the epoxy, the allowable temperature at time of application and the method of application shall be as recommended by the manufacturer and as approved by the Engineer.

626.03.04 Barricades. Rocks, asphalt or concrete pieces, construction materials, and other debris shall not be used as a weighting device for barricades; however, sand bags will be permitted as long as a low center of gravity is maintained as approved by the Engineer.

626.03.05 Remove and Re-erect Temporary Signs or Barricades. Signs or barricades to be removed and re-erected will be designated on the plans or in the special provisions. Care shall be taken in removing signs or barricades and no equipment or devices shall be used which might cause damage thereto. If damage is done due to the negligence of the Contractor, the sign shall be replaced in kind at the expense of the Contractor.

Any new posts or hardware necessary to re-erect the sign or barricade shall be furnished by the Contractor, shall be of the same kind as those in the original, if available, and the cost thereof shall be included in the contract price for the work. The Department reserves the right to furnish the Contractor with such materials as it deems advisable, and these materials shall be used in the re-erection of the signs or barricades in lieu of materials removed.

Sign and barricade reflectorized faces shall be cleaned in accordance with the provisions of subsection 626.03.02, "Signs."

METHOD OF MEASUREMENT

626.04.01 Measurement. The quantity of new or re-erected temporary signs to be measured for payment will be the number of square feet of sign surface in the completed work measured in accordance with the dimensions shown on the plans.

Barricades will be measured for payment and will be identified by the type set forth in the proposal. If more than one (1) type of barricade is involved,

separate measurement will be made for each type given. Type I and Type III barricades shall be measured for payment by the linear foot of width of the barricade or barricades erected complete in place to the satisfaction of the Engineer. Temporary traffic cones shall be measured for payment on an each basis complete in place to the satisfaction of the Engineer.

Temporary signs and barricades shall remain a part of the completed project.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

626.05.01 Payment. The accepted quantity of new and re-erected temporary signs measured as provided in subsection 626.04.01, "Measurement," will be paid for at the contract unit price bid per square foot.

The accepted quantity of barricades measured as provided above will be paid for at the contract unit price bid per linear foot for Type I and Type III barricades. Type II barricades, traffic delineators, and Type A and Type B barricade warning lights will be paid for at the contract unit price bid per each.

The accepted quantity of temporary traffic cones measured as provided above will be paid for at the contract unit price bid each which price shall be full compensation for furnishing and installing the cones complete in place in the accepted work.

The above prices shall be full compensation for erecting, removing and re-erecting, excavation and backfill, and for all materials and labor necessary to complete the work.

Partial payments for new signs and barricades may be made as set forth under subsection 109.06, "Partial Payments."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Temporary Signs	Square Foot
Temporary Barricades (Type I)	Linear Foot
Temporary Barricades (Type III)	Linear Foot
Temporary Barricades (Type II)	Each
Temporary Signs, Remove and Reset	Square Foot
Temporary Signs, Remove	Square Foot
Temporary Signs, Reset	Square Foot
Temporary Traffic Cones	Each
Temporary Delineators	Each
Temporary Barricade Warning Lights (Type A)	Each
Temporary Barricade Warning Lights (Type B)	Each

SECTION 627

PERMANENT SIGNS

DESCRIPTION

627.01.01 General. This work shall consist of furnishing, erecting, and installing all signs, sign supports, and other materials required for highway signs in accordance with the MUTCD Manual, the Standard Highway Sign Book, current editions, including the Nevada Supplement, these specifications as shown on the plans, and as directed by the Engineer. This item does not include construction signs used for traffic control during construction or temporary signs.

The work shall generally consist of:

(a) Overhead signs, including concrete foundations, steel sign posts and frames, and reflectorized aluminum sign panels.

(b) Ground mounted signs consisting of concrete foundations, steel or timber sign posts, reflectorized aluminum sign panels, and appurtenances.

This item does not include sign illumination systems.

627.01.02 Shop Drawings. When overhead sign structures are to be furnished, the Contractor shall submit to the Engineer five (5) sets of shop drawings for each overhead sign structure for approval. Fabrication of the overhead sign structures shall not commence until the shop drawings have been approved by the Department.

Shop drawings for signs will not be required; however, all signs shall conform to the plans and either the Standard Highway Sign Book or the Nevada Supplement thereto. For signs which are shown on the sign summary sheets and are not included in the Standard Highway Sign Book or the Nevada Supplement, special sign design sheets shall be furnished by the Department to the successful bidder after the time of award of the project. The special design sheets shall include such information as letter heights, spacing between letters and words, borders, sign radii, etc. These signs shall conform to the special design sheets as well as the drawings noted in the plans.

MATERIALS

627.02.01 General. Materials shall conform to the following applicable requirements:

Sign Materials.....Section 716

627.02.02 Reflectorization. The types of reflective materials to be used for signing shall be as follows:

(a) Type III reflective sheeting for sign background, letters, numerals, symbols, borders, and accessories shall be used on all overhead guide signs.

(b) Type I reflective sheeting for sign background and Type III reflective sheeting for letters, numerals, symbols, borders, and accessories shall be used on all other guide signs unless noted on the plans.

(c) All letters, numerals, symbols, borders, and accessories shall be directly applied to the sign background on all guide signs unless otherwise noted on the plans.

(d) Type III reflective sheeting shall be used on the following warning and regulatory signs:

1. Railroad Crossing W10–1.
2. Narrow Bridge W5–2 or W5–2a.
3. Two Way Traffic W6–3.
4. Do Not Enter R5–1.
5. Wrong Way R5–1a.
6. Stop R1–1.

(e) Type I reflective sheeting shall be used on all other warning and regulatory signs unless otherwise noted on the plans.

627.02.03 Overhead Guide Signs. All overhead guide signs shall be reflectorized aluminum.

CONSTRUCTION

627.03.01 Panel Fastenings. The panel sections shall be provided with suitable fastenings, as shown on the plans, to permit easy attachment to the supporting frames. These fastenings shall be so designed as to carry the full design load with a factor of safety of not less than one and one-half (1½). Panel sections shall be provided with closure strips at the joints.

Panel fastenings for use on sign panels covered with Type III reflective sheeting shall utilize nylon washers for contact between the reflective sheeting and the metal washer.

627.03.02 Closure Strips. Closure strips shall be anchored by aluminum rivets as shown on the plans. Rivets shall be the same color as the sign face. Closure strips are required only on aluminum sign panels.

627.03.03 Installation. Sign locations indicated on the plans are approximate only. Final determination of sign locations will be made in the field by the Engineer.

Signs and sign islands shall be constructed to the lines and grades given by the Engineer and in accordance with the design and locations shown on the plans.

All signs shall be erected as specified before, during, or immediately after the completion of bituminous plantmix surface operations.

The date of installation, consisting of month and year, shall be permanently stamped on the back of each sign with metal dies and shall be visible only on close inspection. The stamp shall be placed on the lower right hand corner when facing the rear of the sign.

Each sign face shall be thoroughly cleaned according to the reflective material manufacturer's recommendations, and all undesirable material that is visible on the face of the sign shall be removed. The use of abrasives or other cleaning material that will scratch or otherwise deface shall not be permitted.

Should the Contractor be required to cover any directional signs that are not

functional, he shall not cover the front of the sign surface with adhesive material.

Sign islands shall be constructed as roadway embankment in conformity with Section 203, "Excavation and Embankment." Structure excavation and backfill shall conform to the requirements of Sections 206, "Structure Excavation," and 207, "Backfill." Anchor bolts shall be set true to line and grade and posts shall be plumb. Sign illumination systems shall conform to the requirements of Section 623, "Signals and Lighting."

Sign faces of all directional signs facing public traffic and directing such traffic to a portion of the project not yet open to public traffic shall have the message covered.

Care shall be exercised at all times in the handling, storing, transporting, and erecting of the signs. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

Pipe sign posts may be field cut and drilled to adjust for local conditions when approved by the Engineer. Flame cutting will not be permitted. All field cuts and abraded areas on steel pipe posts shall be thoroughly cleaned and given two (2) coats of paint having a high zinc dust content conforming to the requirements of Federal Specification MIL–P–21035.

Extending the lengths of sign posts to adjust for local conditions by splicing or welding will not be permitted.

627.03.04 Removal. This work shall consist of removal of existing permanent sign panels, posts, and footings as shown on the plans and as directed by the Engineer. Existing sign panels and posts that are removed shall be stockpiled on the jobsite at locations determined by the Engineer and shall remain the property of the State. The Contractor shall remove and dispose of all concrete from sign posts prior to stockpiling as directed by the Engineer.

The Contractor shall exercise care when removing and stockpiling signs that are designated for removal. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

627.03.05 Reset. This work shall consist of resetting existing sign panels on new posts and footings as shown on the plans and as directed by the Engineer. Existing sign panels will normally be all or portions of those removed in accordance with subsection 627.03.04, "Removal," unless otherwise indicated on the plans or directed by the Engineer.

627.03.06 Tests. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Department. The Contractor shall furnish the Department with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

METHOD OF MEASUREMENT

627.04.01 Measurement. Permanent signs, other than signs listed as "Overhead," shall be measured for payment by the number of square feet of

sign face surface. The square footage shall be determined from the dimensions of sign panels in the completed and accepted work.

The quantity of "Permanent Signs, Remove" to be measured for payment will be the actual number of square feet of sign panel surface removed.

The quantity of "Permanent Signs, Reset" to be measured for payment will be the actual number of square feet of sign panel reset.

Sign panels on permanent signs listed as "Overhead" signs shall be measured by the square foot of sign panel in the completed and accepted work.

Sign supports for permanent signs listed as "Permanent Overhead Sign Support Structures" shall be measured and paid for on the lump sum basis.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

627.05.01 Payment. Sign panels shall be paid for at the contract unit price bid per square foot for "Permanent Signs (Ground Mounted) (Metal Supports)," or "Permanent Signs (Ground Mounted) (Timber Supports)," as the case may be, which shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals and for doing all the work involved in furnishing and erecting permanent signs (other than signs listed as overhead) complete in place as shown on the plans and as herein specified, including but not limited to structure excavation and backfill, concrete foundations, supports, sign islands, and making all required tests.

The contract unit price bid per square foot for "Permanent Signs, Remove" shall be considered full compensation for removal of sign panels, sign posts, and removal and disposal of sign footing, stockpiling of existing sign posts and panels for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work as shown on the plans and as directed by the Engineer.

The contract unit price bid per square foot for "Permanent Signs, Reset" shall be considered full compensation for furnishing and installing new posts and footings and resetting existing permanent sign panels thereon and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work as shown on the plans and as directed by the Engineer.

Sign panels shall be paid for at the contract unit price bid per square foot for "Permanent Sign Panels (Overhead)" which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals and for doing all the work involved in furnishing and erecting permanent sign panels (for signs listed as overhead signs) complete in place as shown on the plans and herein specified.

Sign supports shall be paid for at the contract lump sum price bid for "Permanent Overhead Sign Support Structures" which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals and for doing all the work involved in furnishing and erecting permanent sign supports (for all signs listed as overhead signs) complete in place as shown on the plans and as herein specified, including structure

excavation and backfill, concrete foundations, cast-in-place concrete piles, structural steel posts and frame, sign islands, and making all required tests.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Permanent Signs (Ground Mounted) (Metal Supports)	Square Foot
Permanent Signs (Ground Mounted) (Timber Supports)	Square Foot
Permanent Signs, Remove	Square Foot
Permanent Signs, Reset	Square Foot
Permanent Sign Panels (Overhead)	Square Foot
Permanent Overhead Sign Support Structures	Lump Sum

20

SECTION 628

MOBILIZATION

DESCRIPTION

628.01.01 General. The item of mobilization shall consist of preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site, for the establishment of all offices, buildings, and other facilities necessary for work on the project, as well as all other work and operations which must be performed, or costs incurred, not otherwise paid for prior to beginning work on the various items on the project site.

This item shall also consist of furnishing water and electricity to all Department furnished field laboratories used on the project. The amount of water and electricity supplied shall be that necessary to satisfy the requirements of the Department and the Contractor shall make all necessary connections of both water and electricity to the laboratories.

PAYMENT

628.05.01 Payment. Payment for this work will be made at the contract lump sum bid price for "Mobilization."

When mobilization does not appear as an item in the proposal, the cost of such work shall be considered included in the contract unit price bid for other items of work and no additional compensation shall be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Mobilization	Lump Sum

SECTION 633

PAVEMENT MARKERS

DESCRIPTION

633.01.01 General. This work shall consist of furnishing and placing pavement markers at the locations shown on the plans or where directed by the Engineer.

The markers shall have the shape, dimensions and tolerances shown on the plans.

Pavement markers will be of the type and color shown on the plans or specified herein.

MATERIALS

633.02.01 Non-Reflective Pavement Markers. Non-reflective pavement markers shall consist of a heat-fired, vitreous, ceramic base and a heat-fired, opaque, glazed surface to produce the properties required in these specifications. The glazed surface shall not be present on the bottom of the marker which will be cemented to the road surface. The markers shall be produced from any suitable combination of intimately mixed clays, shales, tales, flints, feldspars, or other inorganic material which will meet the properties herein required. The markers shall be thoroughly and evenly matured and free from defects which effect appearance or serviceability.

The top surface of the non-reflective marker shall be convex and the radius of curvature shall be between three and one-half (3½) inches and six (6) inches, except that the radius of the one-half (½) inch nearest the edge may be less. Any change in curvature shall be gradual. The top and sides shall be smooth and free of mold marks, pits, indentation, air bubbles, or other objectionable marks or discolorations. The base of the marker shall be flat (the deviation from a flat surface shall not exceed five one hundredths (0.05) inch) and free from gloss glaze or substances that may reduce its bond to the adhesive.

The nonreflective ceramic type markers shall conform to the following tests:

(a) Adhesive bond strength to bottom surface of the marker using adhesives specified in subsection 633.02.03, "Epoxy Adhesive for Pavement Markers"	700 p.s.i. min.
(b) Glaze Thickness	0.005" min.
(c) Moh Hardness	6 min.
(d) Directional Reflectance (white markers only)	
1. Glazed Surface	75 min.
2. Body of Marker	70 min.
(e) Yellowness Index (white markers only)	
1. Glazed Surface	0.07 max.
2. Body of Marker	0.12 max.
(f) Autoclave	Glaze shall not spall, crack or peel
(g) Strength	750 lbs. min.
(h) Water Absorption	2.0 percent max.

633.02.02 Reflective Pavement Markers. Reflective pavement markers shall be of the prismatic reflector type consisting of methyl methacrylate or suitable compounded acrylonitrile budadiene styrene (ABS) shall be filled with a mixture of an inert thermosetting compound and filler material. The exterior surface of the shell shall be smooth and contain one methyl methacrylate prismatic reflector face of the color specified.

The infra-red curves of the compounded methyl methacrylate or acrylonitrile butadiene styrene shell shall match approved curves on file in the Materials and Testing Department.

The base of the marker shall be flat (the deviation from a flat surface shall not exceed five one hundredths (0.05) inch), rough textured and free from gloss or substances which may reduce its bond to the adhesive.

The color of the reflector when illuminated by an automobile headlight shall be an approved clear. Off-color reflection shall constitute grounds for rejection.

The reflective type markers shall conform to the following tests:

(a) Adhesive bond strength to bottom surface of the marker using adhesives specified in subsection 633.02.03, "Epoxy Adhesives for Pavement Markers"	500 p.s.i. min.
(b) Reflectance	Specific Intensity Clear
0 degree Incidence Angle, min.	3.0
20 degrees Incidence Angle, min.	1.2
(c) Strength	2,000 lbs. min.

633.02.03 Epoxy Adhesive for Pavement Markers. Unless otherwise ordered in writing by the Engineer, markers shall be cemented to the pavement with Standard Set Type adhesive as provided in Section 728, "Epoxy." If approved by the Engineer, the Contractor, for his convenience, may substitute Rapid Set Type for the Standard Set Type at no additional cost to the State.

If Rapid Set Type adhesive is ordered by the Engineer, the difference in cost between furnishing and applying Standard Set Type and Rapid Set Type will be paid for as extra work as provided in subsection 109.03, "Extra and Force Account Work."

633.02.04 Blank.

633.02.05 Tests. Pavement markers and Epoxy adhesives for Pavement Markers shall comply with the requirements of these specifications when tested in accordance with Nevada Test Method No. T500.

The Contractor shall furnish the Engineer with certificates of compliance executed by the manufacturers of the markers and epoxy adhesives attesting that they conform to these specifications.

CONSTRUCTION

633.03.01 Installation. The portion of the highway surface to which the markers are to be bonded by the adhesive shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive. Cleaning

shall be done by blast cleaning on Portland cement concrete. The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom of the marker in a quantity sufficient to result in complete coverage of the area of the contact of the marker with no voids present and with a slight excess after the marker has been pressed in place. The marker shall be placed in position and pressure applied until firm contact is made with the pavement. Excess adhesive around the edge of the marker, excess adhesive on the pavement, and adhesive on the exposed surfaces of the markers shall be immediately removed. Soft rags moistened with mineral spirits conforming to Federal Specifications TT–T–291 or kerosene may be used if necessary, to remove adhesive from exposed faces of pavement markers. No other solvent shall be used. The markers shall be protected against impact until the adhesive has hardened to the degree designated by the Engineer.

The adhesive requires that the mixing operation and placing of the markers be done rapidly. When hand mixing or machine mixing the Standard Set Type adhesive, all markers shall be aligned and pressed into place within five minutes after mixing is started. When hand mixing adhesive, not more than one (1) quart shall be mixed at one time. Any mixed batch which becomes so viscous that the adhesive cannot be readily extruded from under the marker on application of slight pressure shall not be used.

Automatic mixing equipment for the epoxy adhesive shall use positive displacement pumps and shall properly meter the two components in the specified ratio, plus or minus five (5) percent by volume of either component. At the beginning of each day and at any other time ordered by the Engineer, the ratio shall be checked by the Contractor in the presence of the Engineer. This check shall be made by disconnecting the mixing heads, or using suitable bypass valves, and filling two suitable containers with the unmixed components. The mixing head shall properly mix the two components so that there is no trace of black or white streaks in the mixed materials.

The Standard Set Type adhesive shall not be used when either the pavement or the air temperature is less than fifty (50) degrees Fahrenheit. No markers shall be installed if the relative humidity of the air is greater than eighty (80) percent or if the pavement is not surface dry. The Engineer shall be the judge as to when the adhesive has set sufficiently to bear traffic.

All markers shall be installed to the line established by the Engineer. Reflective markers shall be installed in such a manner that the reflective face of the marker is at right angles to a line parallel to the roadway centerline.

No pavement markers shall be installed over longitudinal or transverse joints of the pavement surface.

633.04.01 Measurement. The quantity of each type of pavement marker to be measured for payment as units will be the number of each type determined by actual count complete in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

633.05.01 Payment. The accepted quantity of pavement markers measured as provided in subsection 633.04.01, "Measurement," will be paid for at the contract unit prices bid per each for "Non-Reflective Pavement Mark-

ers'' and ''Reflective Pavement Markers,'' which shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and placing pavement markers, complete in place, including adhesives, as shown on the plans, as specified herein and as directed by the Engineer.

All payments will be made in accordance with subsection 109.02, ''Scope of Payment.''

Payment will be made under:

Pay Item	Pay Unit
Non-Reflective Pavement Markers	Each
Reflective Pavement Markers	Each

SECTION 634

PAVEMENT MARKING FILM

DESCRIPTION

634.01.01 General. This work shall consist of furnishing and placing permanent pavement marking film at the locations shown on the plans and as directed by the Engineer.

MATERIALS

634.02.01 General. Materials shall conform to the requirements of section 732, "Permanent Pavement Marking Film."

CONSTRUCTION

634.03.01 General. Permanent Pavement Marking Film shall be applied as per manufacturer's recommendations. After installation has been completed, the following test for adhesion shall be made at locations determined by the Engineer:

Within forty-eight (48) hours after application, a one (1) inch strip shall be cut transversely through the material. Approximately one (1) inch of the strip material shall be lifted from the substrata to enable gripping in a clamp attached to a spring-loaded balance or scale. The material shall resist a minimum eight (8) pound pull applied at an angle of ninety (90) degrees relative to the surface of the adhered film strip.

METHOD OF MEASUREMENT

634.04.01 Measurement. The quantity of Permanent Pavement Marking Film (Varies) measured for payment will be the number of square feet complete in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

634.05.01 Payment. The quantity of Permanent Pavement Marking Film (Varies), measured as provided above, will be paid for at the contract unit price bid per square foot. Such price shall be full compensation for furnishing all materials, as well as all labor, tools, equipment, and incidentals necessary to complete the work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Permanent Pavement Marking Film (Varies)	Square Foot

SECTION 635

TEMPORARY PAVEMENT STRIPING TAPE

DESCRIPTION

635.01.01 General. This work shall consist of furnishing, locating, placing, maintaining, and removing continuous temporary pavement striping tape and temporary pavement striping tape (pilot line).

MATERIALS

635.02.01 General. Temporary striping tape shall be yellow or white or any combination thereof as directed by the Engineer and shall conform to the following requirements:

"Temporary Striping Tape," "Temporary Striping Tape (Pilot Line)," and "Temporary Arrows" may be either Type 1 or Type 2 tape. The Contractor will have the option as to which type is used.

Type 1 tape is more readily removable from the surface and is recommended for use on surfaces which are not designated to be covered or removed and on temporary areas where traffic patterns are to be altered.

Type 2 tape is much more difficult to remove from the surface and is recommended for use on surfaces which are to be covered or removed in which case removal of the tape will not usually be required.

Should the Contractor elect to use either Type 1 or Type 2, it shall be his responsibility for its removal when required and removal shall be to the satisfaction of the Engineer.

Type 1 tape shall conform to the following requirements:

Composition. The removable preformed pavement marking film shall consist of a white or yellow mixture of high quality of polymeric materials, pigments, and glass beads, with a reflective layer of beads bonded to the top surface. A nonmetallic medium coated with a pressure sensitive adhesive shall be incorporated to facilitate removal. The white and yellow materials shall have the following initial average reflectance values at two-tenths (0.2) degree and five-tenths (0.5) degree observation angles and eighty-six (86) degrees entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard 370:

	White		Yellow	
Observation Angle	0.2°	0.5°	0.2°	0.5°
Specific Luminance	1770	1270	1310	810

Removability. The marking film shall be completely removed from asphalt and Portland cement concrete either manually or with a roll-up device, at temperatures above forty (40) degrees F. (four (4) degrees C.) without use of heat, solvents, grinding, or sand blasting.

Type 2 tape shall conform to the following requirements:

Composition. The metallic backed striping tape shall consist of a white or

yellow retroreflective film on a conformable metallic backing, precoated with a pressure sensitive adhesive.

CONSTRUCTION

635.03.01 General. Temporary Striping Tape (Pilot Line) shall be four (4) inch by twelve (12) inch sections and shall be placed on traffic lane lines at forty (40) foot intervals with the longer side parallel to traffic. Lane lines and forty (40) foot intervals shall be located by the Contractor as approved by the Engineer. Prior to the end of a working day, temporary pilot line shall be placed on each new lift of bituminous surfacing over which public traffic is directed. The exception to the foregoing is that the State shall be responsible for placing pilot line on the final open-graded surface using State furnished labor, materials, and equipment.

Continuous temporary striping tape shall be furnished, located, applied, maintained, and removed by the Contractor at locations indicated on the plans or determined by the Engineer.

The surface to which the tape (pilot line or continuous) is applied shall be dry, free of oils, grease, dust, and dirt. The tape shall be tamped down immediately after application in order to obtain a proper bond, and shall be removed from final pavement surface and where necessary to reroute public traffic as directed by the Engineer.

It should be considered normal and expected that portions of the temporary striping tape shall have to be replaced during the life of the contract. The locations and extent of these replacements shall be determined by the Engineer.

METHOD OF MEASUREMENT

635.04.01 Measurement. Continuous temporary pavement striping tape shall be measured for payment on a linear foot of tape basis. Temporary pavement striping tape (pilot line) shall be measured for payment on a station basis and each one hundred (100) feet shall constitute the unit of one (1) station. Measurement shall be made on the initial application at locations approved by the Engineer.

Temporary arrows shall be measured for payment on an each basis.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

635.05.01 Payment. Continuous Temporary Striping Tape will be paid for at the contract unit price bid per linear foot.

Temporary Striping Tape (Pilot Line) will be paid for at the contract unit price bid per station.

Temporary Arrows will be paid for at the contract unit price bid per each.

The contract unit prices bid shall apply regardless of whether Type 1 or Type 2 tape is furnished at the Contractor's option.

The unit prices bid shall also be full compensation for furnishing all materials as well as all labor, equipment, tools, and incidentals necessary to

install and maintain tape, replacement when necessary, and removal when required.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Temporary Striping Tape	Linear Foot
Temporary Striping Tape (Pilot Line)	Station
Temporary Arrows	Each

SECTION 636

TEMPORARY PAINTED PAVEMENT MARKING

DESCRIPTION

636.01.01 General. This work shall consist of the application of temporary pavement striping paint and traffic beads as hereinafter specified and as directed by the Engineer.

MATERIALS

636.02.01 General. All materials shall conform to the requirements set forth in the following sections:

Traffic Paint	Section 729
Traffic Beads	Section 730

CONSTRUCTION

636.03.01 General. Prior to the end of each day's paving operations or prior to allowing public traffic on new bituminous surfaces, the Contractor shall be required to apply new painted traffic lines for the safety and guidance of public traffic. An exception to the foregoing is that paint striping by the Contractor shall be limited to all bituminous courses except the final wearing course. Striping of the final wearing course shall be accomplished by State forces, and said work is not a part of the contract.

Striping patterns to be followed by the Contractor shall be set forth in the special provisions unless otherwise directed by the Engineer and it shall be the Contractor's responsibility to properly locate painted traffic lanes.

If, in the sole opinion of the Engineer, normal wear of the painted pavement striping dictates repainting, said work shall be measured for payment in accordance with subsection 636.04.01 of these specifications. Should repainting be required for any purpose other than normal wear as determined by the Engineer, all costs of such repainting shall be borne by the Contractor and no additional compensation shall be allowed therefor.

Pavement to receive paint shall be clean and dry as approved by the Engineer. All paint striping shall be a single application and shall require traffic beads.

Paint shall be applied with a machine capable of dispensing beads immediately after paint is applied. The use of thinner shall not be permitted unless otherwise approved by the Engineer.

The pavement striping shall be protected from public traffic until dry by the use of traffic cones or by any other means approved by the Engineer. Should the Contractor elect to heat the paint in order to reduce drying time, the paint shall not be heated above one hundred forty-five (145) degrees F.

Application rates shall be as follows:

Paint (Yellow or White)	Minimum Film Thickness—8 mils dry
Beads	6 pounds per gallon of paint

For quality control the Engineer shall check the application at the beginning of each day's striping and as often thereafter as considered necessary by him. If equipment settings fail to produce quality striping within the limits specified, striping shall be stopped until the cause is corrected.

METHOD OF MEASUREMENT

636.04.01 Measurement. The quantity of Painted Pavement Striping shall be measured for payment on a mile basis for the type specified.

The double solid yellow line shall be considered as a single line when measured for payment. Gaps in the broken lines shall be included in the mile measurement.

Traffic beads shall not be measured for payment but the cost thereof shall be included in the payment for Painted Pavement Striping.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

636.05.01 Payment. The accepted quantity of "Painted Pavement Striping(*)," measured as provided above, shall be paid for at the contract unit price bid per mile which price shall be considered full compensation for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work (including paint striping protection) as approved by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Painted Pavement Striping(*)	Mile

*Color and type (solid or broken) shall be indicated in the estimate and proposal.

SECTION 637

POLLUTION CONTROL

DESCRIPTION

637.01.01 General. This work shall consist of temporary pollution control measures which may be shown on the plans, specified in the special provisions, or ordered by the Engineer during the life of the contract. Said work is intended to provide prevention, control, and abatement of water and air pollution within the limits of the project and to minimize damage to the work and to adjacent property and streams or other bodies of water.

The Contractor shall, seven (7) days prior to the preconstruction conference, submit for acceptance his proposed plans and schedules, in duplicate, for accomplishing the prevention of erosion and pollution that may occur due to his operations. No work shall be started until these schedules and methods of operation have been accepted by the Engineer.

This work shall include furnishing and applying a dust palliative as a temporary erosion and dust control measure as directed by the Engineer. It is intended that the dust palliative by used to control erosion and dust hazards on a limited basis to control those problems in the interim between construction of roadways and the application of permanent measures such as mulching and seeding.

MATERIALS

637.02.01 General. The binder for dust palliative shall be a resin emulsion that is miscible in water in the proportions hereinafter provided, is noncorrosive, and is effective as a dust palliative.

Resin emulsion shall be composed of from fifty-seven (57) percent to sixty-three (63) percent of semiliquid petroleum resin and the remainder water to which a suitable emulsifying agent has been added. The binder shall be mixed with additional water at the jobsite and at the approximate rate of four (4) parts of water to one (1) part of binder. The exact rate of mixture to be determined by the Engineer. The resin emulsion shall be readily miscible with water and when diluted with any hard water in proportions of one (1) part emulsion to ten (10) parts water shall shown no signs of breakdown or separation of the petroleum resin base. Resin emulsion which has been stored in closed containers at temperatures above freezing for a period up to three (3) months shall show no signs of separation. Any resin emulsion which has been stored for more than three (3) months shall not be used until tested and approved.

CONSTRUCTION

637.03.01 General. The temporary pollution control measures shall be as directed from time to time by the Engineer for the duration of the contract. The Engineer may revise and bring up to date any temporary control measures

or instigate any new temporary pollution control measures found necessary as the work progresses.

The temporary control measures to prevent pollution of streams or other bodies of water or of the air and to minimize damage to the work and to adjacent property and streams or other bodies of water, as directed by the Engineer and paid for on a force account basis, are in addition to any other measures provided for within the contract that are to be paid for as separate bid items.

It is expected that compliance with these requirements will necessitate performance of certain items of work at a different time or in a different manner than has been considered normal construction practice in the past and that such revisions in scheduling of work will interfere with said normal construction practices.

Unless otherwise approved by the Engineer, the total area of erosible earth material exposed by the Contractor's operations shall not exceed seven hundred fifty thousand (750,000) square feet before either temporary pollution control or temporary or permanent erosion control measures are accomplished.

Where erosion damage is probably due to the nature of the material or to the season of the year, the Contractor's operations shall be so scheduled that pollution control features will be installed concurrently with or immediately following grading operations.

Compliance with the requirements of this section shall in no way relieve the Contractor from his responsibility to comply with the other provisions of the contract except that he will not be required to replace, at his expense, any of the temporary pollution control work that is damaged by action of the elements.

All erosion control work required elsewhere in the specifications or on the plans will be paid for under the provisions for the applicable contract items of work therefor.

The Contractor shall coordinate this temporary pollution control work, as required by the Engineer, with such erosion control work as may be specified elsewhere in the contract to the extent practicable to assure that effective and continuous pollution control is maintained during the construction of the project.

The Contractor shall, insofar as practicable, conduct his operations in such a manner as to minimize the effects of erosion and air pollution due to his operations upon areas within the limits of the project, haul roads, material sites, disposal sites, and upon adjacent properties, streams, and other bodies of water.

Mixing of the dust palliative material shall be accomplished by simultaneously placing the binder and water in the spreading equipment or by other mixing methods that will produce equivalent results. The resulting mixture shall be applied with pressure type water distributor trucks equipped with a spray system or pressure type asphalt distributors conforming to the requirements of subsection 404.03.02. The mixture shall be applied at a total rate of approximately one-half (½) gallon per square yard in two (2) applications. The exact rate of application to be determined by the Engineer.

METHOD OF MEASUREMENT

637.04.01 Measurement. The required quantity of temporary pollution control work, except as set forth below, shall be measured for payment on a force account basis in accordance with subsection 109.03.

The required quantity of dust palliative will be measured by the ton prior to addition of water at the jobsite. In the event that volumetric measurement is permitted by the Engineer, the dust palliative shall be measured as set forth in subsection 109.01 for asphaltic emulsion.

The cost of furnishing materials and equipment and conditioning crushing, mixing, and processing plants and other equipment to comply with the requirements of NRS Chapter 445, especially the "Air Quality Regulations" adopted by the State Commission of Environmental Protection, January 18, 1972, including watering for dust control, shall be considered as included in the contract price bid for other items of work and no further compensation will be allowed therefor.

BASIS OF PAYMENT

637.05.01 Payment. Payment for "Temporary Pollution Control" measured as provided above, will be paid for by force account.

Dust palliative, measured as provided above, shall be paid for at the contract unit price bid per ton for "Dust Palliative" which price shall be full compensation for furnishing the material, adding and mixing additional water at the jobsite, applying the mixture, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, complete and in place as indicated on the plans and as directed by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Temporary Pollution Control	Force Account
Dust Palliative	Ton

SECTION 640

RETAINING WALLS

DESCRIPTION

640.01.01 General. This work shall consist of furnishing all materials and erecting masonry block retaining walls at the locations and in accordance with the details shown on the plans and as specified herein.

This work shall also consist of furnishing all components and constructing mechanically stabilized earth walls at locations shown on the plans and as specified herein. The face of the walls shall be composed of precast concrete panels unless otherwise noted.

MATERIALS AND INSTALLATION

640.02.01 Masonry Retaining Wall. Masonry block shall be slump block or split face block of the dimensions shown on the plans and conforming to the requirements of ASTM Designation C–90, Grade N, Type 1.

All concrete block and mortar, except the grout used in filling cells, shall have an integral color pigment added. The color pigment shall consist of a synthetic mineral oxide specifically manufactured for coloring masonry products and mortar. The integral coloring shall be obtained by mixing the pigment material with the other ingredients in a sequence and by methods that will result in a uniform color.

Unless otherwise indicated on the plans, the color of the concrete blocks and mortar shall approximate Federal Standard No. 37875 as shown in Table IX of Federal Standard No. 595a. The final color selections shall be subject to approval by the Engineer.

The Contractor shall notify the Engineer not less than ten (10) days in advance of shipment of concrete blocks to the jobsite in order that sufficient time may be allowed for testing prior to shipment.

The Contractor shall require the supplier of the concrete block to provide a separate storage area for concrete blocks which have been tested and accepted but are stockpiled for later delivery to the jobsite.

Mortar for masonry walls shall be composed of one (1) part by volume of Portland cement to not more than three (3) parts surface dry sand by volume, to which may be added hydrated lime in the quantity of twenty-five (25) percent by volume of cement. Hydrated lime shall be treated as an addition to and not as replacing any cement. Portland cement and sand shall conform to the requirements of Sections 701 and 706, respectively, of these specifications. Prepared mortar mix may be substituted for hydrated lime at the discretion of the Engineer. Hydrated lime shall conform to ASTM Designation C–207, Type S.

All grout used to fill cells shall attain a minimum compressive strength of two thousand five hundred (2,500) pounds per square inch in twenty-eight (28) days when tested in accordance with Test Method No. Nev. T427.

All reinforcing steel shall be Grade 60 conforming to the requirements of Section 505 of these specifications.

The PVC premolded joint filler shall conform to the requirements of subsection 707.03.03, "Waterstops," part "(c) Polyvinyl Chloride," of these specifications.

The masonry wall shall be true and plumb and shall be laid in straight uniform courses in common bond with vertical joints aligned over center of unit below as shown on the drawings. All vertical cells shall be in alignment.

Mortar joints shall be three-eighths (3/8) inch thick. All blocks shall be laid with horizontal and vertical mortar joints buttered along face edges for a depth equal to thickness of face shells, also on the webs surrounding the cells to be filled. Vertical joints shall be shoved tight. Joints shall be concave tolled smooth. All wall surfaces shall be kept clean and free from mortar blotches.

Reinforcement shall be placed as shown on the plans.

All cells shall be solidly filled with grout in conformance with the details shown on the plans.

At the conclusion of the masonry work, the Contractor shall remove mortar daubs and smears and clean down the walls.

Precautions shall be taken when constructing the masonry walls in freezing weather or when the temperature is below forty (40) degrees F. Suitable materials shall be provided to heat materials, protect the work from cold and frost, and to insure that mortar or grout will harden without freezing.

640.02.02 Mechanically Stabilized Earth Wall. The Contractor is hereby advised that methods to provide the "Mechanically Stabilized Earth" process are patented and the Contractor shall provide for such use by suitable legal agreement with the patentee and pay all costs connected therewith.

The names and addresses of approved patentees for "Mechanically Stabilized Earth" are as follows:

The Reinforced Earth Company
5 Siernegate Plaza, Suite 305
Roseville, CA 95678
(916) 786-3070

Retained Earth Corporation
1077 Dell Avenue
Campbell, CA 95008
(408) 866-8454

Reinforced Soil Embankment Wall
By: Hilfiker Retaining Walls
P.O. Drawer L
Eureka, CA 95501
(707) 443-5091

The Contractor will have the option as to which patentee he selects.

The following shall be established during the design of mechanically stabilized earth:

(1) Minimum acceptable safety factors with regard to aspects of external wall behavior shall be as follows: Overturning—2.0; Sliding—1.5; Overall slope stability subsequent to and during wall construction—1.5. Any anticipated total or differential settlement shall also be addressed.

(2) The retaining wall shall be designed for a minimum service life of seventy-five (75) years.

(3) Minimum acceptable safety factors with regard to aspects of internal wall behavior such as reinforcement pull-out capacity, reinforcement durabil-

ity, and reinforcement internal material stresses (e.g., maximum allowable stress in steel reinforcement is five-tenths (0.5) fy.).

Regardless of the option used, the following requirements shall apply:

(a) It shall be the sole responsibility of the Contractor to contact the patentee of his choice and arrange for plans, specifications, and detailed design computations to be prepared. The plans, specifications, and detailed design computations shall be submitted to the Engineer in triplicate for approval prior to beginning construction of the walls. Design computations indicating the proposed corrosion protective system to be used for metals, based upon the physical properties of backfill material to be used, shall also be included. Four (4) weeks time will be required by the Department for approval. There shall be no adjustment in the contract completion time due to the option chosen.

(b) "Mechanically Stabilized Earth Wall" and "Mechanically Stabilized Earth Backfill" quantities will be adjusted upward or downward depending on the option chosen.

(c) The elevation of the top of the wall and the geometrics shall remain the same as that shown on the plans regardless of the option chosen.

All mechanically stabilized earth backfill used in the structure volume shall be free from organic and otherwise deleterious materials and shall conform to the following gradation limits as determined by Test Method No. Nev. T206–D.

Sieve Size	Percent Passing
6 inch	100
3 inch	75–100
No. 4	40–75
No. 200	0–25

The Plasticity Index (P.I.) as determined by Test Method No. Nev. T212–C shall not exceed six (6).

The foregoing sieve analysis and plasticity index requirements shall apply regardless of the source chosen by the Contractor.

The source of mechanically stabilized earth backfill shall also meet the following additional requirements:

PH Value	5.0 to 10.0
Resistivity	3,000 ohm/cm minimum
Chlorides	200 ppm maximum
Sulphates	1,000 ppm maximum

Acceptance tests for these requirements shall be performed by the Department.

These additional source requirements are not to be used as production controls (project controls) but as "Mechanically Stabilized Earth Backfill" source controls.

Mechanically stabilized earth backfill may be used from sources not meeting the above additional source requirements if all metal parts in contact with backfill (except reinforcing steel encased in concrete) are cleaned and epoxy coated in accordance with the requirements of Section 505 of these specifica-

tions. After curing, the coating thickness shall be eighteen (18) mils minimum. Nuts and bolts need not be coated prior to installation but shall be field coated after installation in accordance with Section 505.

The Contractor shall have the option of epoxy coating the metal parts or finding a source for backfill that will meet the requirements. All epoxy coating will be at the Contractor's expense.

Material for the soil reinforcing system shall be furnished and be specified by the patentee the Contractor selects.

The soil reinforcing system shall be fabricated to the dimensions and tolerances shown on the approved plans. All soil reinforcing materials shall be carefully inspected to insure they are true to size and free from defects that may impair their strength and durability.

Soil reinforcing and attachment devices shall conform to the following:

(1) Reinforcing Strips. Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to ASTM A572 grade 65 (AASHTO M223) or equal. Galvanization shall conform to the minimum requirements of ASTM A123 (AASHTO M111).

(2) Reinforcing Mesh. The reinforcing mesh shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of ASTM A82 and shall be welded into the finished mesh fabric in accordance with ASTM A185. Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements ASTM A123. Any damage done to the mesh galvanization prior to the installation shall be repaired in an acceptable manner and provide a galvanized coating comparable to that provided by ASTM A123.

(3) Tie Strips. The tie strips shall be shop fabricated of a hot rolled steel conforming to the minimum requirements of ASTM A570, grade 50 or equivalent. Galvanization shall conform to ASTM A123 (AASHTO M111).

(4) Coil Embed. One (1) inch coil embed shall be fabricated of cold drawn steel wire conforming to AISI C1035. It shall be galvanized in accordance with ASTM A164 or equal.

(5) Coil Embed Grease. The cavity of each coil embed shall be completely filled with no-oxid type grease or equal.

(6) Coil Bolt. The one (1) inch diameter coil bolt shall have two (2) inches of thread. It shall be cast of 80–55–06 ductile iron conforming to ASTM A536. Galvanization shall conform to ASTM A164 or equal.

(7) Fasteners. Fasteners shall consist of one-half (½) inch diameter, hexagonal cap screw bolts and nuts, which are galvanized and conform to the requirements of ASTM A325 (AASHTO M164) or equivalent.

(8) Connector Pins. Connector pins and mat bars for the Reinforced Soil Embankment system shall be fabricated from ASTM A36 steel and welded to the soil reinforcement mats as shown on the plans. Galvanization shall conform to ASTM A123 (AASHTO M111).

All joint material required by the system chosen shall conform to the material and installation requirements of the patentee.

Concrete for the face panels shall conform to the requirements of Section 501 of these specifications and shall have a minimum twenty-eight (28) day

compressive strength of four thousand (4,000) p.s.i. Panels shall be considered acceptable for placement in the wall when the seven (7) day concrete strengths exceed eighty-five (85) percent of the twenty-eight (28) day requirement or when compression tests indicate strengths equal to the twenty-eight (28) day requirements regardless of curing age. The State shall perform, or have performed, all necessary sampling and testing.

The coil embedments, tie strip guides, or other galvanized devices shall not contact or be attached to the panel reinforcing steel.

The panels shall be cast on a flat area. The concrete in each unit shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand-tamping as may be necessary to force the concrete into the corners of the forms and prevent the formation of stone pockets or cleavage planes. Clear form oil of the same manufacture shall be used throughout the casting operation.

The units shall be cured for a sufficient length of time so that the concrete will develop the specified compressive strengths. Any panel pour which does not reach specified strength within twenty-eight (28) days shall be rejected.

Concrete surface for the front face shall have the finish approved by the Engineer and for the rear face an unformed surface finish. Rear face of the panel shall be roughly screeded to eliminate open pockets of aggregate and surface distortions in excess of one-fourth (1/4) inch.

All units shall be manufactured within the following tolerances:

All dimensions within three-sixteenths (3/16) inch.

Angular distortion with regard to the height of the panel shall not exceed two-tenths (0.2) inch in five (5) feet.

Surface defects on formed surfaces measured on a length of five (5) feet not more than one-tenth (0.1) inch.

Acceptance of the concrete face panels with respect to compressive strength will be determined on a lot basis. The lot will consist of all production units (batches of concrete or panels) produced within a week's for seven (7) day production operation. Production units shall be randomly selected in accordance with the production day sample sizes of Table A and tested for compressive strength. Compression tests shall be made on standard six (6) inch by twelve (12) inch test specimens prepared in accordance with Test Method No. Nev. T428. Compressive strength testing shall be conducted in accordance with Test Method No. Nev. T475.

TABLE A

Production Day Quantities	Sample Size
—35 cu.yd. (—50 panels)	1
35–70 cu.yds. (50–100 panels)	2
—70–150 cu.yds. (100–150 panels)	3
+105 (+150 panels)	5

When standard six (6) inch by twelve (12) inch test specimens are utilized, a minimum of four (4) cylinders shall be cast for each production unit sampled. Two (2) of these specimens shall be cured in the same manner as the panels and tested at seven (7) days. The remaining two (2) cylinders shall be cured in accordance with Test Method No. Nev. T428, Section D.1 and tested at twenty-eight (28) days. A test result will be the average compressive strength of two (2) cylinders.

Acceptance of the lot will be made if all acceptance tests in a lot are greater than four thousand (4,000) p.s.i. or provided no individual twenty-eight (28) day compressive strength test result falls below three thousand six hundred (3,600) p.s.i. and the average twenty-eight (28) day compressive strength of all test results for the lot equals or exceeds the acceptance limits set forth in Table B.

The acceptance limits of Table B shall also apply to core compressive strength tests results.

TABLE B
Lot Acceptance Limits

Number of Lot Acceptance Tests	Average of All Lot Acceptance Tests Must Equal or Exceed These Limits
3–7	4000+0.33R*
8–15	4000+0.44R*
16+	4000+0.46R*

*Range: The difference between the largest and smallest acceptance test result.

Units shall be subject to rejection because of failure to meet any of the requirements specified above. In addition, any or all of the following defects shall be sufficient cause for rejection:

Cracked or severely chipped panels.

Defects that indicate imperfect moulding.

Defects indicating honeycombed or open texture concrete.

The date of manufacture, production lot number, and piece mark shall be clearly described on the rear face of each panel.

All units shall be handled, stored, and shipped in such a manner as to eliminate the danger of chipping, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported on firm blocking to protect the panel connection devices and the exposed exterior finish.

Prior to completion of the project, the Contractor shall furnish written certification to the effect that all materials and manufacture of reinforcing and the strips, fasteners, and joints fillers furnished for use on this project were in compliance with the applicable portions of these specifications.

The foundation for the mechanically stabilized earth embankment shall be graded as indicated on the plans. Prior to wall construction, the foundation shall be compacted to a depth of not less than six (6) inches and to not less than ninety-five (95) percent of the maximum density as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or T103 may be used to determine the in-place density. Test method to be determined by the Engineer. Any foundation soils found to be unsuitable or incapable of sustaining the required compaction shall be removed and replaced with mechanically stabilized earth backfill.

Any unreinforced concrete leveling footings shall be constructed at the panel foundation level. The footing shall be cured a minimum of twelve (12) hours before placement of wall panels.

If a precast concrete leveling course is used it shall be placed below the wall panel excavation line. A thin layer of sand or fine native soil may be placed beneath the leveling course to provide a smooth and level bearing surface for the leveling course.

Precast concrete panels shall be placed in successive horizontal lifts in the sequence shown on the plans as backfill placement proceeds. As backfill

material is placed behind a panel, the Contractor may need to provide suitable bracing or wedging on the exterior side of the panel to maintain the panel in a vertical position. The vertical tolerance and alignment of the wall shall not exceed one-half (½) inch in ten (10) feet. All bracing and wedging shall be removed at the end of fill placement.

Mechanically stabilized earth backfill placement shall closely follow the erection of each lift of panels. At each soil reinforcement level, backfill shall be roughly leveled prior to placing and fastening the soil reinforcement. Soil reinforcing shall be placed normal to the wall unless otherwise shown on the working drawings. The backfill shall be placed in uniform horizontal layers not exceeding eight (8) inches in loose thickness before compaction and shall closely follow panel erection. Each layer of backfill shall be moistened as necessary and thoroughly compacted to achieve the patentee's required percentage of maximum density or ninety-five (95) percent of maximum density, whichever is greater, as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or T103 may be used to determine the in-place density. The test method shall be determined by the Engineer. In general, the wall erection and backfill placement shall be in accordance with the requirements of the patentee.

Backfill shall be placed in such a manner as to avoid any damage or disturbance of the wall materials or misalignment of the facing panels. Any wall materials which become damaged during backfill placement shall be removed and replaced at the Contractor's expense. Any misalignment or distortion of the wall facing panels due to placement of backfill outside the limits of this specification shall be corrected by the Contractor at his expense.

METHOD OF MEASUREMENT

640.04.01 Measurement. The quantity of "Masonry Retaining Wall" to be measured for payment shall be the actual number of square feet of masonry block wall placed in the completed and accepted work, measured along the face of the wall, and such measurement shall be limited to the masonry block portion placed above the top of the footing. The block facing and dovetail anchor system on concrete walls are to be measured as "Masonry Retaining Wall."

All concrete in footings for masonry retaining wall shall be measured and paid for as "Class A or Class AA Concrete" of the type required in accordance with Section 502 of these specifications.

All reinforcement in footings and masonry block walls shall be measured and paid for as "Reinforcing Steel" in accordance with Section 505 of these specifications.

All structure excavation and granular backfill for masonry walls will be measured and paid for as "Structure Excavation" or "Granular Backfill," as the case may be, in accordance with Section 206 or 207 of these specifications.

The quantity of "Mechanically Stabilized Earth Wall" to be measured for payment will be the number of square feet of the completed wall measured on the exterior face of the wall from the top of footing to the top of panel or coping.

The quantity of "Mechanically Stabilized Earth Backfill" will be measured for payment by the cubic yard. Backfill limits will be as shown on the approved plans for the option shown.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

640.05.01 Payment. Masonry block walls, measured as provided above, shall be paid for at the contract unit price bid per square foot for "Masonry Retaining Wall," which price shall be considered full compensation for all concrete block, mortar, and grout as well as for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to erect the block walls above the footings as shown on the plans, as herein specified, and as directed by the Engineer.

The contract unit price bid per square foot for "Masonry Retaining Wall" shall also include furnishing and installing the sash blocks and PVC premolded joint filler and for cutting the masonry blocks for the bond beams.

Also included in the contract unit price bid per square foot for "Masonry Retaining Wall" is the cost of the block facing and the dovetail anchor system.

"Mechanically Stabilized Earth Wall" shall be paid for at the contract unit price bid per square foot which price shall be full compensation for all costs assessed to the Contractor for the option shown and for erecting all panels, installing joint fillers and reinforcing strips, and for all labor, materials, supplies, tools, equipment, and incidentals necessary to complete the work. It shall also include all concrete, reinforcing steel, and all work involved for the footing and coping. The contract unit price bid does not include roadway and structure excavation which are paid for as separate bid items in accordance with the limits as shown on the plans.

"Mechanically Stabilized Earth Backfill" shall be paid for at the contract unit price bid per cubic yard which price shall be considered full compensation for furnishing, hauling, placing, and compacting the material complete in place in the accepted work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Masonry Retaining Wall	Square Foot
Mechanically Stabilized Earth Wall	Square Foot
Mechanically Stabilized Earth Backfill	Cubic Yard

SECTION 646

WATERPROOFING AND DAMPPROOFING

DESCRIPTION

646.01.01 General. This work shall consist of furnishing and applying membrane waterproofing or dampproofing to the surface of the concrete as shown on the plans and as specified in these specifications. Membrane waterproofing consists of a coating of primer and a firmly bonded membrane composed of two (2) layers of saturated glass fabric and three (3) moppings of waterproofing asphalt. Dampproofing consists of a coating of primer and two (2) moppings of waterproofing asphalt. This work does not include bridge deck waterproofing and when such work is required, it shall be accomplished in accordance with the requirements contained in Section 647, "Bridge Deck Waterproofing."

MATERIALS

646.02.01 General. Waterproofing asphalt shall conform to the specifications of ASTM Designation D449, Type A for below ground and Type B for above ground, except that the ductility for Type B shall be five (5) minimum. The provisions in said D449 relating to felt, asbestos felt, and cotton fabrics shall not apply.

Primer for use with asphalt in waterproofing below and above ground level shall conform to the specifications of ASTM Designation D41.

Fabric shall conform to the specifications of ASTM Designation D1668 for bituminous glass fabric treated with asphalt.

CONSTRUCTION

646.03.01 General. All concrete surfaces which are to be waterproofed shall be reasonably smooth and free from holes and projections which might puncture the membrane. The surface to be waterproofed or dampproofed shall be dry and shall be thoroughly cleaned of dust and loose materials.

No primer or asphalt shall be applied in wet weather, nor when the temperature is below sixty-five (65) degrees Fahrenheit, without authorization in writing from the Engineer.

The primer shall be applied to the surface and allowed to dry before the first coat of asphalt is applied.

The waterproofing asphalt shall be applied at a temperature of not less than three hundred (300) degrees Fahrenheit, nor more than three hundred fifty (350) degrees Fahrenheit.

646.03.02 Membrane Waterproofing. Membrane waterproofing shall not be applied to any surface until the Contractor is prepared to follow its application with the placing of the backfill within a sufficiently short time that the waterproofing will not be damaged as a result of exposure to weathering. Any waterproofing membrane which loses its bond with the concrete shall be

removed and replaced with new membrane waterproofing by the Contractor at his expense.

Beginning at the low point of the surface to be waterproofed, the waterproofing asphalt shall be thoroughly mopped onto the surface. A strip of fabric of one-half (1/2) the width of the roll shall be rolled onto the hot asphalt immediately and carefully pressed into place so as to eliminate all air bubbles and obtain close conformity with the surface. This strip and an adjacent section of the surface of a width equal to slightly more than one-half (1/2) the width of the fabric being used, shall then be mopped with hot asphalt and a full width of the fabric shall be rolled into this, completely covering the first strip, and shall be pressed into place as before. This second strip and an adjacent section of the concrete surface shall than be mopped with hot asphalt and the third strip of fabric shingled on so as to lap the first strip by not less than two (2) inches. This process shall be continued until the entire surface is covered, each strip of fabric lapping at least two (2) inches over the last strip but one (1). The entire surface shall then be mopped with hot asphalt. Special care shall be taken at all laps to see that they are thoroughly sealed down.

The work shall be so regulated that at the close of the day's work the final mopping of asphalt shall have been applied to all the fabric in place.

646.03.03 Dampproofing. The waterproofing asphalt shall be thoroughly mopped onto the surface to be dampproofed. When the first mopping of asphalt has set sufficiently, the entire surface shall then be mopped with the second coating of hot asphalt. Special care shall be taken to see that there are no skips in the coatings and that all surfaces are thoroughly covered.

METHOD OF MEASUREMENT

646.04.01 Measurement. The quantities of membrane waterproofing or dampproofing placed as shown on the plans or directed by the Engineer will be determined by the square yard from measurement of the area covered by the membrane waterproofing or dampproofing.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

646.05.01 Payment. The quantity of membrane waterproofing or dampproofing measured as provided above, shall be paid for at the contract unit price bid per square yard for "Membrane Waterproofing" or "Dampproofing," which payment shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in applying the waterproofing membrane or dampproofing, complete in place, as shown on the plans and as specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Membrane Waterproofing	Square Yard
Dampproofing	Square Yard

SECTION 647

BRIDGE DECK WATERPROOFING

DESCRIPTION

647.01.01 General. This work shall consist of cleaning existing concrete bridge decks of all dirt, dust, loose aggregate or concrete, grease, oil, residual asphalt and road tars and curing compounds, and furnishing and applying a waterproofing membrane to the surface of bridge decks, as shown on the plans and as specified in these specifications. The membrane shall consist either of a laminate or plasticized coal tar, a reinforced modified asphalt membrane, or a single-component, hot applied, elastomeric polyvinyl chloride coal tar.

MATERIALS

647.02.01 General. (a) Prefabricated Coal Tar Membrane. Coal tar membrane, primer, and mastic shall conform to the following:

1. The membrane shall be a laminate of synthetic resin reinforced coal tar and a nonwoven synthetic fibrous mat. Membrane shall be supplied in rolls not over five (5) feet in width nor six hundred (600) feet in length.

2. Thickness of membrane shall be seventy (70) mils plus or minus five (5) mils.

3. Flexibility—The membrane shall pass one (1) inch mandrel bent test at zero (0) degree to ten (10) degrees F. when tested in accordance with ASTM D146.

4. Softening point of tar used in membrane shall not be less than two hundred thirty (230) degrees F. when tested as specified in ASTM D36.

5. The tensile strength of the membrane when tested in accordance with ASTM D882 shall be as follows:

Method A, one (1) inch wide strip speed of pull two (2) inches per minute.

At zero (0) degree F., an average of three (3) samples pulled longitudinally one thousand five hundred (1,500) p.s.i. minimum.

At forty (40) degrees F., an average of three (3) samples pulled longitudinally nine hundred (900) p.s.i. minimum.

At one hundred twenty (120) degrees F., an average of three (3) samples pulled longitudinally four hundred (400) p.s.i. minimum.

At zero (0) degree F., an average of three (3) samples pulled transversely one thousand four hundred (1,400) p.s.i. minimum.

At forty (40) degrees F., an average of three (3) samples pulled transversely seven hundred (700) p.s.i. minimum.

At one hundred twenty (120) degrees F., an average of three (3) samples pulled transversely three hundred (300) p.s.i. minimum.

6. Elongation—The elongation of the membrane when tested as specified in ASTM D882 shall be as follows:

Method A, one (1) inch wide strip speed of pull two (2) inches per minute.

At zero (0) degree F., an average of three (3) samples pulled longitudinally thirty (30) percent elongation minimum.

At forty (40) degrees F., an average of three (3) samples pulled longitudinally forty (40) percent elongation minimum.

At one hundred twenty (120) degrees F., an average of three (3) samples pulled longitudinally fifty (50) percent elongation minimum.

At zero (0) degree F., an average of three (3) samples pulled transversely twenty-five (25) percent elongation minimum.

At forty (40) degrees F., an average of three (3) samples pulled transversely thirty (30) percent elongation minimum.

At one hundred twenty (120) degrees F., an average of three (3) samples pulled transversely thirty-five (35) percent elongation minimum.

7. Water Penetration—Water penetration of the membrane shall be zero (0) when tested under a hydrostatic head of one (1) meter for twenty-four (24) hours in accordance with ASTM D583, Method 3.

8. Density—The material shall weigh no less than forty-five one-hundredths (0.45) pounds per sq. ft.

9. Mastic shall be as recommended by the manufacturer of the membrane.

10. Primer shall be as recommended by the manufacturer of the membrane.

(b) Reinforced rubberized asphalt membrane. Membrane shall be composed of a layer of rubberized asphalt laminated to a synthetic puncture resistant reinforcing mesh. The membrane is to be supplied in rolls interwound with a special release paper to protect the adhesive surface until ready for use. The membrane shall conform to the following specifications:

1. Total membrane thickness shall be a minimum of sixty-five (65) mils.

2. Membrane tensile strength[1] shall be fifty (50) lbs. per inch minimum when tested in accordance with ASTM D882[2] and the elongation at break[3] tested as specified in ASTM D882[2] shall be fifteen (15) percent[4] minimum.

3. Peel adhesion to primed concrete shall not be less than five (5) lbs. per inch of width when tested as specified in Fed. TT–S–00227.

4. Low temperature pliability when tested in accordance with ASTM D146, bent one hundred eighty (180) degrees around a one-fourth (1/4) inch mandrel at minus twenty-five (25) degrees F., shall have no cracks in the rubberized asphalt or reinforcement.

5. Softening point of the rubberized asphalt when tested in accordance with AASHTO T53 shall be one hundred sixty-five (165) degrees F. minimum.

6. Water absorption of the membrane after three (3) days water immersion at room temperature shall not be more than two (2) percent when tested in accordance with ASTM D1228.

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[1]Breaking factor in machine direction.

[2]Method A, one (1) inch wide strip with four (4) inches initial grip separation and four (4) inch gage length at two (2) inches per minute. Average five (5) samples.

[3]In machine direction.

[4]At seventy-three and four-tenths (73.4) degrees F. plus or minus three and six-tenths (3.6) degrees F.

(c) Single-component, hot applied, elastomeric polyvinyl chloride coal tar shall be applied to the deck and face of the curb as a liquid coating with asphalt roll roofing sheet, forty (40) pound grade conforming to ASTM D224, free of mica, talc, or dust laid over the hot liquid membrane. Applications shall be by squeegee.

The liquid membrane shall conform to the following specifications:

Property	Specification Requirement
Penetration	120 cm. max. after 48 hour dur.*
Flow	No flow after 72 hours at 158° F. (70° C.).*
Bond	Pass 3 cycles at 0° F. (—17° C.).*
Resilience	60% min. after 48 hours at 77° F. (25° C.).*
Elongation	500% min. at ½ in./min. at 77° F. (1.27cm./min. at 25° C.).**
Flexibility	Shall not crack when bent over a 1 in. (2.5 cm.) mandrel at 0° F. (—17° C.).
Artificial Weathering	Shall not flow, show tackiness, presence of an oil-like film, reversion to a mastic-like substance, formation of blisters on the surface, form internal voids, surface cracking or crazing, hardening, or loss of resilient rubber-like properties after 160 hours exposure.***
Film Integrity	Install in a single coat minimum 90 mils (0.23 cm.) thick.
Color	Black.
Chemical Resistance	Material must be impervious to deicing chemicals and salt.
References	*ASTM D1190, D1191 **California Water Resources Board Method CL-2 ***Federal Specifications SS-S-200D

(d) Reinforced Polymer Modified Asphalt Membrane. Membrane shall consist of a prefabricated reinforced laminate consisting of an impregnated fiberglass mesh sandwiched between layers of a polymer modified bitumen with a top surface of polyester film. The membrane is manufactured with a paper release winder, wound in rolls four (4) feet wide by fifty (50) feet long. The membrane shall conform to the following requirements:

Color: Black.

Thickness: Seventy-five (75) mils plus or minus five (5) mils.

Permeance (Water Vapor Transmission): One one-hundredth (0.01) perms. ASTM E-96, Method B.

Softening Point: Ring and Ball two hundred twenty-five (225) degrees F. minimum. ASTM D36.

Needle Penetration: Thirty (30) minimum at seventy-seven (77) degrees F., five (5) sec. at one hundred (100) g. ASTM D5.

Weight Per Square Yard: Three and one-tenth (3.1) to three and seven-tenths (3.7) lbs.

The Contractor shall furnish the Engineer with a Certificate of Compliance executed by the manufacturer of the bridge deck waterproofing material. Such certificate shall attest that the primer and membrane as produced in the usual course of the manufacturer's trade, conforms to the requirements of these specifications.

CONSTRUCTION

647.03.01 General. Concrete bridge deck and curb shall be swept free of loose material and any foreign matter removed such as loose aggregate,

21

dust, grease, or residual asphalt. Any material that is not compatible with the waterproofing material to be used shall be removed prior to placing the waterproofing. All sharp protrusions which would, in the Engineer's opinion, puncture the membrane shall be removed from the surface. Sharp corners to be covered may be rounded (outside) and chamfered (inside). Portland cement concrete or mortar shall be used to make chamfers.

If Type C waterproofing is used, any new concrete curing compound shall be removed from the surface by light sandblasting.

Should the manufacturer require a primer, the primer shall be of the type and shall be applied at the rate recommended by said manufacturer.

No primer or membrane shall be applied in wet weather, nor when the ambient temperature is below forty (40) degrees F., without authorization in writing from the Engineer.

Placement of any type membrane shall always commence on the low side of the bridge deck and proceed across the deck to the high side or to the crown if applicable.

In the event placement of membrane is partially complete and wet weather occurs, all exposed edges shall be sealed with a bead of mastic. Paving shall not be started until the membrane surface is dry.

It is especially important to avoid puddling of the primer, or excessively thick applications. The primer shall dry "tack-free" before applying the membrane. The drying time will vary dependent on weather conditions; normally thirty (30) minutes to two (2) hours is sufficient. Under normal conditions, twelve (12) hours is the maximum allowable drying time; after which the surface should be reprimed. Shorter maximum drying times may be considered in dusty areas, or in any case where the deck is subject to accumulation of dust or dirt. If the surface of the primer was dry before becoming contaminated, it may be blown or swept clean to assure adhesion of the membrane.

The Contractor shall take all necessary precautions to avoid discoloration or staining of any bridge surfaces which will remain exposed upon completion of the project. Any such surfaces which become discolored or stained shall be thoroughly cleaned at the Contractor's expense as directed by the Engineer.

The prefabricated membrane shall be supplied in rolls interwound with a special paper or release film. This paper or release film shall be left in place during application and until the overlay of plantmix is applied. The prefabricated membrane may be mechanically applied with equipment designed specifically for this application and which will handle membrane in maximum widths of five (5) feet and maximum length of six hundred (600) feet. The membrane, applied with this equipment, shall be applied to the primed surface with sufficient pressure to insure proper placement with a minimum overlap of three (3) inches and without wrinkles. The prefabricated membrane strip shall be rolled immediately behind the laydown procedure with a roller weighing not less than one hundred (100) pounds. The membrane shall be placed in a manner by which a "shingling" effect will be achieved thereby allowing any accumulation of water to drain toward the curb areas where the deck drains are located. However, membrane shall be applied using careful practices as recommended by the manufacturer and as approved by the Engineer.

A permanent protective cover shall be applied to the completed Type A, Type C, or Type D membrane prior to placing plantmix bituminous surface thereon. The cover shall consist of forty (40) lb. felt, fiberboard, or other material giving equal or better protection as approved by the Engineer. A protective cover shall not be required for Type B membrane.

The approved permanent covering shall be placed over the Type A, Type C, or Type D membrane within the time recommended by the manufacturer and such recommendation shall be in writing to the Engineer; however, in any case the membrane shall be covered prior to any temporary suspension of the work unless otherwise approved in writing by the Engineer.

Once the membrane and the permanent protective cover have been installed and until the plantmix bituminous surface overlay has been placed full depth over the membrane, vehicular traffic (other than that necessary to place the overlay on that deck) will not be permitted thereon, unless otherwise permitted in writing by the Engineer.

The plantmix overlay shall be at temperatures over two hundred seventy-five (275) degrees F., but less than three hundred twenty-five (325) degrees F., unless otherwise specified.

Placement of the plantmix overlay shall always commence on the low side of the bridge deck and proceed across the deck to the high side or to the crown if applicable.

Hauling vehicles shall dump into the paver and the paver shall not be placed in motion until the hauling vehicle has pulled away. Pushing of hauling vehicles with the paver or contact between the hauling vehicle and the paver when the paver is in motion shall not be permitted.

The Contractor shall take every precaution necessary to prevent damage to the prefabricated membrane when placing the overlay of plantmix, only rubber tired or flat rubber tracked overlay paving equipment will be permitted. Tires or tracks shall not be permitted to run on longitudinal seams of any type membrane or protective covering. Any damage caused by the Contractor's equipment shall be repaired or replaced to the satisfaction of the Engineer, at the Contractor's expense.

Bituminous surfacing or an approved temporary covering shall be placed over the membrane within the time recommended by the manufacturer. Both the time within which the membrane must be covered and the type of temporary covering shall be as approved by the manufacturer and such approval shall be in writing to the Engineer; however, in any case the membrane shall be covered prior to any temporary suspension of the work unless otherwise approved in writing by the Engineer.

When Type B membrane is used the following additional instructions shall be followed:

The membrane shall be applied by removing the release sheet as the membrane is unrolled with the tacky surface in contact with concrete surface. The membrane shall be laid in the direction opposite the direction of paving to assure that the end laps are formed in the direction of paving. End laps shall be staggered. Edges and ends of the membrane shall be overlapped a minimum of two and one-half (2½) inches.

This membrane shall be laid carefully to assure uniform laps and to minimize wrinkles and fishmouths. In addition the membrane shall be laid

from the low point to the high point in shingle fashion. The membrane must be terminated at the curb or barrier with a three-eighths (3/8) inch bead of mastic trowelled to thickness of one-eighth (1/8) inch and laid as close as possible to the curb or barrier.

Because the membrane has its own built-in flexible protection layer, no protection cover will be used with Type B membrane. This is of prime importance in order to assure the best possible bond of asphalt to the membrane.

When Type C membrane is used the following additional instructions shall be followed:

(a) Hot membrane shall be applied to the prepared surfaces at a rate to yield a minimum of ninety (90) mils thickness. Application temperature of the liquid membrane shall be a minimum of two hundred fifty (250) degrees F. to two hundred ninety (290) degrees F. Application temperature, equipment, and procedures recommended by the membrane manufacturer shall be strictly adhered to. The membrane after cooling shall exhibit no surface blisters, crazing, or cracking.

(b) Immediately following application and before it cools, the membrane shall be covered with forty (40) lb. grade asphalt roll roofing, conforming to ASTM D224. Roofing shall be laid parallel to the centerline of the bridge roadway unless otherwise approved by the Engineer. The roofing strips shall be butt jointed. The entire roofing application shall be free of wrinkles, bubbles, and other placement defects. Wrinkles and fishmouths shall be slit and repaired.

(c) Following the placement of the roofing, a bead of the hot membrane shall be run along the cove where the curb meets the roofing material. The bead shall fill the void preventing water from entering between the roofing and the membrane.

(d) The plantmix overlay shall be at a maximum temperature of two hundred sixty-five (265) degrees F. at laydown and at a minimum temperature of two hundred thirty-five (235) degrees F. at compaction.

When Type D membrane is used the following additional instructions shall be followed:

The membrane shall not be applied during wet weather conditions, nor when the deck and ambient air temperatures are below fifty (50) degrees F. The primer may be applied at a temperature not lower than forty (40) degrees F. Application at a lower temperature may be approved by the Engineer provided adequate heating equipment is used to warm the membrane to a satisfactory condition.

The membrane shall be applied with the sticky side down after removing the release paper during the unrolling process. The membrane may be moved about on the primed deck after unrolling to position it correctly. Each roll shall be applied to cover the exposed tacky edge of the adjoining roll to form a water tight seal, and should overlap the end of the preceding roll by at least four (4) inches. The membrane shall be positioned at the curb and at expansion dams and joints as specified by the Engineer.

A block wax applicator, a squeegee, or a tool similar to a squeegee with a soft facing such as carpet, or a hand roller, preferably a multiple segment

rubber tired one, shall be used to force the membrane into firm contact with the primed deck, to eliminate wrinkles and to prevent entrapped air. Successive rolls shall be overlapped to achieve a shingling effect over crowned or sloped decks.

When rolls are overlapped at the end the top surface of the bottom layer shall be heated with a propane torch to melt the polyester film and fuse to the underside of the top layer. This heat fusion method shall also be used to bond the membrane to the primed curb or joint surfaces by pressing or rolling the heated membrane into firm contact with the primed surface. Any torn or cut areas or narrow overlaps shall be patched by the heat fusion method, overlapping a minimum of four (4) inches.

The membrane shall be cut and molded around irregular contours such as drains or vents, using the torch where necessary to aid conformance and to fuse the membrane to the primed surface where appropriate.

After the membrane has been in place for several hours blisters or bubbles may develop under the membrane. These blisters are primarily caused by outgassing of the concrete, but contributory factors are improperly dried or cured concrete, insufficiently dried or skinned over primer and entrapped air. The blisters are larger and more numerous at high temperatures, and may disappear completely at lower temperatures such as may occur overnight. Larger blisters shall be deflated by puncturing with a slender blade or a pointed instrument like an ice pick, taking care to puncture in a horizontal direction parallel to the deck so the puncture will be self sealing.

Rubber tired vehicles, including pavers, may be driven or operated on the membrane covered surface provided care is taken to avoid sudden starts, stops, or turns. The membrane shall be cleaned of any contamination which may have accumulated prior to paving.

The asphalt shall be between two hundred ninety (290) degrees F. and three hundred forty (340) degrees F. at the time of application, and shall be compacted according to applicable specifications.

METHOD OF MEASUREMENT

647.04.01 Measurement. The quantities of bridge deck waterproofing placed as shown on the plans and as required by these specifications will be determined by the square foot from measurement of the area covered.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

647.05.01 Payment. The quantity of waterproofing, measured as provided above, shall be paid for at the contract unit price bid per square foot for "Bridge Deck Waterproofing," which payment shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in cleaning and preparing the surface to be sealed, including Portland cement concrete or mortar, applying the waterproofing, complete in place, as shown on the plans and as specified in these specifications, and as directed by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Bridge Deck Waterproofing	Square Foot

SECTION 660

PNEUMATICALLY PLACED CONCRETE MORTAR

DESCRIPTION

660.01.01 General. This work shall consist of lining ditches and channels, slope paving and constructing warped sections, and other similar features with mortar pneumatically placed in accordance with the plans, these specifications, and the special provisions.

Pneumatically placed mortar shall consist of either dry mixed fine aggregate and Portland cement applied by a suitable mechanism, to which mixture the water is added immediately previous to its expulsion from the nozzle, or mortar premixed by mechanical methods and pneumatically applied through a nozzle onto the prepared foundation.

MATERIALS

660.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform with all the requirements for such materials as set forth in this specification and in Division III, "Material Details."

The dry mixture shall consist of one (1) part Portland cement to not more than four (4) parts sand, thoroughly mixed in a dry state. Measurement may be either by volume or weight. Before placing the proportioned materials in the hopper of the application gun, all lumps three-eighths (3/8) inch or over shall be removed by screening.

The premixed mortar shall contain not less than six hundred ten (610) pounds of Portland cement per cubic yard, fine aggregate, and water. A maximum of thirty (30) percent pea gravel may be substituted for fine aggregate. The maximum size of pea gravel shall be such that one hundred (100) percent passes the one-half (1/2) inch screen and at least ninety (90) percent passes the three-eighths (3/8) inch screen.

Admixtures may be used with the premixed mortar as provided in Section 501 of these specifications.

Reinforcement for ditch lining and slope paving shall be of the sizes shown on the plans, and shall conform to the requirements of Section 505 of these specifications.

Header boards consisting of two (2) inches by four (4) inches redwood lumber furnished and placed in the concrete slope paving shall be as shown on the plans. Lumber used in the construction of header boards shall be commercial grade heart redwood, S4S.

Nails used in construction of header boards shall be commercial quality galvanized nails.

When required, concrete mortar for slope paving shall have an integral color pigment added. The color pigment shall consist of a synthetic mineral oxide specifically manufactured for coloring concrete. The integral concrete coloring shall be obtained by mixing the pigment material with the Portland

cement, aggregates, and water in a sequence and by methods that will result in a uniform mixture.

The color of the finished slope paving surfaces shall conform to Federal Standard Color No. 30324 as shown in Table II of Federal Standard No. 595a or to such other color specified in the special provisions or shown on the plans. The color shall conform to the referee color except that minor deviations in color and tint representative of the method of mixing and applying the slope paving will be acceptable.

The Engineer shall be the sole judge of compliance of the test panel construction with the texture and color requirements of these specifications and for conformance to the required color.

CONSTRUCTION

660.03.01 Preparation of Foundation. The subgrade for paved ditches and slope paving shall be formed by excavating to the required depth below the prepared finish surface grade in accordance with dimensions and design indicated on the plans or as directed by the Engineer.

The subgrade shall be thoroughly compacted. Any soft, spongy, or other unsuitable material shall be removed to such depth as directed and backfilled with suitable material and thoroughly compacted. Water shall be sprinkled on the subgrade during compaction and the subgrade shall be sufficiently moist prior to placing concrete mortar to prevent absorption.

660.03.02 Placing. When a color pigment is required, prior to placing slope paving for use in the work, the Contractor shall construct sufficient test panels to assure the Engineer that the proper color has been obtained and the final panel shall be at least four (4) feet by six (6) feet in size. The panels shall be constructed at the construction site and shall be placed by a method to be used in placing slope pavement.

The Engineer shall be the sole judge of compliance of the test panel construction with the requirement of these specifications.

Header boards shall be installed to conform to the grades of the slope paving, to the dimensions, spaces, and layout shown on the plans.

Header boards shall be held in position with stakes of suitable size and length as shown on the plans.

A constant pressure of not less than forty-five (45) pounds per square inch shall be maintained in the placing machine where the hose length is one hundred (100) feet or less and the pressure shall be increased at least five (5) pounds for each additional fifty (50) feet of hose or fraction thereof.

Water used for hydration at the nozzle shall be maintained at a uniform pressure, which shall not be less than fifteen (15) pounds per square inch greater than the air pressure at the machine.

The nozzle shall be held at such distance and in such position that the flowing steam of material will impinge, as nearly as possible, at right angles to the surface being covered. Any deposits of loose sand shall be cut out.

The Contractor shall do this work only with experienced personnel.

Materials that have been mixed for more than forty-five (45) minutes and

have not been incorporated in the work shall not be used, unless otherwise permitted by the Engineer.

Mortar shall not be placed against frosted or frozen surface. If mortar is placed during cold weather it shall be heated and protected during placing and curing as set forth in Section 501, except mortar shall be maintained at a temperature of not less than fifty (50) degrees Fahrenheit for seventy-two (72) hours after placing and at not less than forty (40) degrees Fahrenheit for an additional four (4) days.

The ditch lining and slope paving shall be constructed without expansion joints. Suitable forms shall be used where necessary to insure a full dimension as shown on the plans at the perimeter of the lining.

Reinforcement shall be placed so as to be in the approximate center of the pneumatically placed concrete mortar. All joints shall be lapped six (6) inches and run continuously throughout paving or between headers.

After the work is completed, the Contractor shall remove all debris from the work.

660.03.03 Finishing. After the mortar has been placed as nearly as practicable to the required depth, the surface shall be checked with a straightedge, and any low spots or depressions shall be brought up to proper grade by placing additional mortar in such a manner that the finished surface will be reasonably smooth and uniform for the type of work involved.

Loose areas of air-blown mortar shall be removed and replaced by the Contractor at his expense.

The surface finish of the exposed slope paving shall be the equivalent of a wood float finish.

Immediately after completion, the surface shall be covered with wet burlap or wet cotton mats and these kept wet for at least seventy-two (72) hours. When approved by the Engineer, mortar may be cured by the use of waterproof paper or by means of a liquid membrane, all conforming to the requirements as set forth in Section 702 of these specifications.

METHOD OF MEASUREMENT

660.04.01 Measurement. Pneumatically placed concrete mortar will be measured in square yards of the actual surface covered to the depth shown on the plans.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

660.05.01 Payment. The quantity, measured as provided above, will be paid for at the contract unit price bid per square yard for "Pneumatically Placed Concrete Mortar (....-inch depth)," which payment shall be full compensation for excavation, backfill, furnishing and installing redwood headers, color pigment, and mortar, and all labor, tools, equipment, and incidentals, and for doing all the work involved in placing the pneumatically placed mortar (including subgrade preparation forms and curing), complete in place,

as shown on the plans, and as specified herein, and as directed by the Engineer.

Reinforcement shall be measured and paid for as specified in Section 505 of these specifications.

Note: If the Contractor elects to place the slope paving by other methods approved by the Engineer, the method of measurement and basis of payment will not be changed.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Pneumatically Placed Concrete Mortar (....-inch depth)	Square Yard

DIVISION III

MATERIALS DETAILS

SECTION 701

PORTLAND CEMENT

SCOPE

701.01.01 Materials Covered. This specification covers the types of Portland cement and the type of blended cement required under pertinent sections of these specifications. Unless otherwise provided, Type II "low alkali" cement or Type IP "blended" cement shall be used for all Portland cement concrete, mortar, cement treated base, and cement treated subgrade.

PHYSICAL PROPERTIES AND TESTS

701.03.01 Requirements. Type II "low alkali," Type III "high early," and Type V "sulphate resistant" cements shall conform to the requirements of ASTM Designation C150 except as hereinafter provided.

Type IP "blended" cement shall conform to the requirements of ASTM Designation C595 except as hereinafter provided:

(a) The pozzolan used shall conform to the requirements of subsection 702.03.08 of these specifications.

(b) The pozzolan constituent shall be limited to a maximum of twenty (20) percent, by weight.

Additionally, Type II "low alkali," Type III "high early," Type V "sulphate resistant," and Type IP "blended" cements shall conform to the following requirements:

The cement shall not contain more than six-tenths (0.6) percent by weight of alkalies calculated as Na_2O plus 0.658 K_2O when determined by flame photometry, using the direct intensity method in the specifications of ASTM Designation C114. Additionally, Type IP "blended" cement which exceeds the allowable alkali content may be used if mortar bars made and tested in accordance with ASTM Designation C227, using the proposed cement and a selected highly alkali-reactive aggregate, show no more than five one-hundredths (0.05) percent expansion at six (6) months.

SECTION 702

CONCRETE CURING MATERIALS AND ADMIXTURES

SCOPE

702.01.01 Materials Covered. This specification covers concrete curing materials, air-entraining admixtures, water retardants, pozzolans, and hydrated lime. Attention is directed to Section 722, "Water," for mixing and curing.

PHYSICAL PROPERTIES AND TESTS

702.03.01 Curing Materials. Curing materials shall conform to the requirements of the following tests:

Burlap Cloth made from Jute or Kenaf	AASHTO M182
Waterproof Paper for Curing Concrete	ASTM C171
Liquid Membrane-Forming Compounds for Curing Concrete	ASTM C309, Type 1D*
Plastic Sheeting	ASTM C171
Pigmented Curing compound for Portland Cement Pavement	ASTM C309, Type 2* and **
White Polyethylene Sheeting (film) for Curing Concrete	ASTM C171

*Except: The curing compound shall not react harmfully with the components of concrete or contain oils, waxes, or other materials which would prevent bonding of traffic marking paints. The film of curing compound shall be continuous, uniform, and free from pinholes, bubbles, or blisters.

**Except: The loss of water in the water retention test shall not exceed four one-hundredths (0.04) gram per square centimeter of surface.

All curing compounds not previously approved shall be tested by a reputable testing laboratory, recognized by the State, who shall certify that the curing compound meets these specifications and requirements. The Contractor shall furnish the Department with this certification prior to using the curing compound.

702.03.02 Blank.

702.03.03 Air-Entraining Admixtures. Air-entraining admixtures shall conform to the requirements of ASTM C260.

702.03.04 Admixtures Other Than Air-Entraining. These admixtures shall meet the requirements of ASTM Designation C494 and shall be clearly marked as to type. In addition to these requirements, the admixtures may be tested by Test Method No. Nev. T467. The concrete so tested and containing admixtures shall not exceed a change in length as specified in subsection 501.02.03.

702.03.05 Hydrated Lime. Hydrated lime shall conform to the requirements of ASTM C207, Type N.

702.03.06 Blank.

702.03.07 White Pigmented Curing Compound—Chlorinated Rubber Base. White pigmented curing compound—chlorinated rubber base shall conform to the following provisions:

Composition:

Pigment Ingredients	Lbs./100 Gals.
Titanium Dioxide, ASTM D476	100.0
Vehicle Ingredients	
Chlorinated Paraffin, MIL-C-429, Type II, (70 percent CL2)	66.0
Chlorinated Paraffin, MIL-C-429, Type I, (43 percent CL2)	66.0
Chlorinated Rubber[1]	165.4
Ethylene Glycol Monoethyl Ether Acetate, MIL-E-7125	265.0
Mineral Spirits, TT-T-291E, Type II, Grade A	265.0
Epoxy Resin[2]	2.0

Characteristics of Finished Material:

Pigment, by weight, percent	9.7 Min.
Weight per gallon in pounds at 77° F.	9.1 Min.
Volatiles, by weight, percent	58.1 Max.
Fineness of grind, Hegman	5 Min.
Viscosity at 77° F., K.U.	64 Max.
Daylight Reflectance, percent (ASTM Designation E97)	60 Min.
Drying Time[3]:	
Set to touch, hours at 77° F.	2 Max.
Dry through, hours at 77° F.	4 Max.
Water Retention, grams net loss at 24 hours[4]	6 Max.
Chlorine[1] percent	65–68
Viscosity, 20 Percent in Toluene, Centipoises at 25° C.	9–14
Specific Gravity	1.555 to 1.565
Index of Refraction	1.550 to 1.560

[1]A twenty-five (25) percent concentration in toluene shall show no haziness or turbidity, and when stored for one (1) week at seventy-seven (77) degrees Fahrenheit shall not corrode the tin plate in a covered tin-coated can.

[2]Liquid, color 5 max. (Gardner), viscosity 100–160 poises at twenty-five (25) degrees Centigrade, epoxide equivalent 180–200.

[3]ASTM D1640, three one-thousandth (0.003) inch wet film thickness on glass panel.

[4]Test Method No. Nev. T552, except that the compound shall be applied at a rate of one (1) gallon per three hundred (300) square feet.

The manufacturer shall include in the curing compound the necessary additives for control of sagging, pigment settling, leveling, or other requisite qualities of a satisfactory working material. Pigmented curing compounds shall be manufactured so that the pigment does not settle badly, does not cake or thicken in the container, and does not become granular or curdled. Any settlement of pigment shall be a thoroughly wetted, soft, mushy mass permitting the complete and easy vertical penetration of a paddle. Settled pigment shall be easily redispersed, with minimum resistance to the sidewise manual motion of the paddle across the bottom of the container, to form a smooth uniform product of the proper consistency.

The Contractor shall furnish the Engineer with a Certificate of Compliance executed by the manufacturer of white pigmented curing compound—chlorinated rubber base. Such certificate shall attest that the curing compound, as produced in the usual course of the manufacturer's trade, conforms to the requirements of these specifications.

702.03.08 Pozzolans. Pozzolanic admixtures shall conform to the requirements of ASTM Designation C618, Type C, Type F, or Type N, except that the loss on ignition shall not exceed five (5) percent.

Pozzolan shall only be accepted from a Department approved prequalified source. Prequalification of a source may be based upon test results by the Department's laboratory or upon a certified report of test results by a qualified independent laboratory showing the pozzolan to be in full compliance with this specification.

Each shipment of pozzolan shall be accompanied by a Certificate of Compliance from the supplier as set forth in subsection 106.05 of these specifications.

SECTION 703

BITUMINOUS MATERIALS

SCOPE

703.01.01 Materials Covered. This specification covers the quality of asphalt cement, liquid asphalt, emulsified asphalt, cationic emulsion, and asphalt for waterproofing and dampproofing.

REQUIREMENTS

703.02.01 Contractor's Responsibility. Bituminous material failing the requirements (including tolerances) of the tests hereinafter prescribed shall be subject to the provisions of subsection 109.02, "Scope of Payment," and attention is directed thereto.

703.02.02 Shipping Notice. When shipment of materials arrive on the project after normal working hours, the Contractor shall notify the Engineer sufficiently in advance to make arrangements for an inspector to be present when the material is sampled.

Shipping notices shall be delivered upon making shipment and shall contain the following information:

(a) Consignee and destination.
(b) State contract number.
(c) Delivery point.
(d) Date shipped.
(e) Car initial and number of truck transport delivery ticket number.
(f) Type and grade of material.
(g) Quantity loaded.
(h) Loading temperature.
(i) Net quantity.
(j) Signature of shipper or authorized representative.

One (1) copy of the shipping notice shall be delivered to the Engineer at Carson City, Nevada, and two (2) copies to the Resident Engineer of the project to which shipment is made.

PHYSICAL PROPERTIES AND TESTS

703.03.01 Refinery Test Report. Refinery test reports shall accompany each load of material delivered to the project, and the reports shall contain the following data:

(a) Date of shipment.
(b) Car initials and number of truck transport delivery ticket number.
(c) Destination and consignee.
(d) State contract number (or State purchase order number, if applicable).
(e) Type and grade of material.
(f) Certificate of grade (certify that material conforms to these specifications, and itemize results on tests performed and date of test).

(g) Signature of refinery's authorized representative.

The Certificate of Compliance shall be used as a basis for permitting immediate use of the material on the job and shall represent conditional acceptance only.

703.03.02 Asphalt Cements. Asphalt cement shall be prepared by the distillation of crude petroleum. This asphalt shall be homogeneous, free from water, and shall not foam when heated to three hundred forty-seven (347) degrees Fahrenheit.

These specifications cover the following viscosity grades: AR–1000 or AC–2.5, AR–2000 or AC–5, AR–4000 or AC–10, AR–8000 or AC–20, and AR–16000 or AC–40.

The various viscosity grades set forth above shall conform to the requirements and methods of testing as shown in Table I or Table IA as the case may be.

TABLE I—Specifications for Asphalt Cement Road Materials
(Viscosity Graded at 140 Degrees Fahrenheit (60 Degrees Centigrade) on RTFC Residue)

Test	AASHTO Test Method	AR-1000	AR-2000	AR-4000	AR-8000	AR-16000	Allowable Tolerance***
Tests on Residue from RTFC Procedure—AASHTO Test Method T240*							
Absolute Viscosity (at 140 deg. F., poise)	T202	750–1,250	1,500–2,500	3,000–5,000	6,000–10,000	12,000–20,000	7.0 Percent
Kinematic Viscosity (at 275 deg. F., cs, min.)	T201	140	200	275	400	550	5.0 Percent
Penetration (at 77 deg. F., 100 g/5 sec., min.)	T49	65	40	25	20	20	4.0 Percent
Percent of original penetration (at 77 deg. F., min.)	T49	-------	40	45	50	52	None
Ductility (at 77 deg. F., cm. min.)	T51	100**	100**	75	75	75	None
Test on Original Asphalt							
Flash point (C.O.C. °F. min.)	T48	400	425	440	450	460	15°F. below
Solubility in Trichlorethylene (percent, min.)	T44	99	99	99	99	99	0.10 Percent below Min.

*TFO may be used but RTFC shall be the referee method.

**If the ductility at seventy-seven (77) deg. is less than one hundred (100) cm., the material will be acceptable if its ductility at sixty (60) deg. is more than one hundred (100) cm.

***When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage of the upper or lower specification limit whichever is applicable.

TABLE IA—Specifications for Asphalt Cement Road Materials
(Viscosity Graded at 140 Degrees Fahrenheit (60 Degrees Centigrade) on Original Asphalt)

Test	AASHTO Test Method	AC-2.5	AC-5	AC-10	AC-20	AC-40	Allowable Tolerance***
Absolute Viscosity (at 140 deg. F., poise)	T202	200-300	400-600	800-1200	1600-2400	3200-4800	7.0%
Kinematic Viscosity (at 275 deg. F., cs, min.)	T201	80	110	150	210	300	2.0%
Penetration (at 77 deg. F., 100 g/5 sec., min.)	T49	200	120	70	40	20	3.0%
Flash point (C.O.C. °F. min.)	T48	325	350	425	450	450	15°F. below
Solubility in Trichlorethylene (percent, min.)	T44	99	99	99	99	99	0.10% below Min.
Tests on Residue from RTFC Procedure—AASHTO Test Method T240*							
Absolute Viscosity (at 140 deg. F., poise max.)	T202	1000	2000	4000	8000	16000	7.0%
Ductility (at 77 deg. F., cm. min.)	T51	100**	100**	50	20	10	None
Spot test (when and as specified) with: ****							
Standard Naphtha solvent		Negative for all grades					
Naphtha-Xylene-solvent, % Xylene	T102	Negative for all grades					None
Heptane-Xylene-solvent, % Xylene		Negative for all grades					

*TFO may be used but RTFC shall be the referee method.

**If the ductility at seventy-seven (77) deg. is less than one hundred (100) cm., the material will be acceptable if its ductility at sixty (60) deg. is more than one hundred (100) cm.

***When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage of the upper or lower specification limit, whichever is applicable.

****The use of the spot test is optional. When it is specified, the Engineer shall indicate whether the standard naphtha solvent, the naphtha-xylene solvent, or the heptane-xylene solvent will be used in determining compliance with the requirement, and also, in the case of xylene solvents the percentage of xylene to be used.

Asphalt cement not conforming to the requirements of Table I or Table IA of these specifications will be assessed demerits in accordance with the graduated increments of the following schedule. Attention is directed to subsection 109.02, "Scope of Payment," of these specifications where demerits will be evaluated for damages sustained by reason of any noncompliance.

AASHTO Test Method	Increment	Demerits (each increment of noncompliance)
T202	AR-1000 or AC-2.5, 4 poises above max. or below min.	1
T202	AR-2000 or AC-5, 8 poises above max. or below min.	1
T202	AR-4000 or AC-10, 16 poises above max. or below min.	1
T202	AR-8000 or AC-20, 32 poises above max. or below min.	1
T202	AR-16000 or AC-40, 64 poises above max. or below min.	1
T201	AR-1000 or AC-2.5, 2 centistokes below min.	1
T201	AR-2000 or AC-5, 4 centistokes below min.	1
T201	AR-4000 or AC-10, 8 centistokes below min.	1
T201	AR-8000 or AC-20, 10 centistokes below min.	1
T201	AR-16000 or AC-40, 16 centistokes below min.	1
T49	0.2 millimeter below min.	1
T49	2 percent below min.	1
T51	5 centimeters below min.	2
T48, T73	5 degrees below min.	1
T44	0.01 percent below min.	1
T102	Positive	21

703.03.03 Liquid Asphalts. Liquid asphalts shall consist of materials conforming to the following classifications. Rapid curing products, designated by the letters RC, shall consist of paving asphalt with a penetration of approximately eighty-five (85) to one hundred (100) fluxed or blended with a naphtha solvent. Medium curing products, designated by the letters MC, shall consist of paving asphalt fluxed or blended with a kerosene solvent. Slow curing products, designated by the letters SC, shall consist of natural crude oils or residual oils from crude asphaltic petroleum. When tested in accordance with the standard methods of AASHTO, the grades of liquid asphalt shall conform to the requirements specified in tables II, III, and IV of this subsection.

TABLE II—Rapid Curing Products

Test	AASHTO Test Method	GRADES; REQUIREMENTS RC-70	RC-250	RC-800	RC-3000	Allowable Tolerance*
Flash Point with Tagliabue Open Cup (percent F.)	T79	.....	80 Min.	80 Min.	80 Min.	15°F. Below
Kinematic Viscosity of Asphalt (at 140°F., cs.)	T201	70–140	250–500	800–1600	3000–6000	2.0 percent
Distillation of Cut-Back Asphalt Products (percent of total distillate to 680°F.):						
to 374°F.	T78	10 Min.	.....	.....	.....	1.0
to 437°F.		50 Min.	35 Min.	15 Min.	.....	1.0
to 500°F.		70 Min.	60 Min.	45 Min.	25 Min.	1.0
to 600°F.		85 Min.	80 Min.	75 Min.	70 Min.	1.0
Residue from distillation to 680°F. (volume percent by difference)		55 Min.	65 Min.	75 Min.	80 Min.	1.0
Tests on residue from distillation:						
Absolute viscosity at 60°C. (140°F.) poises**	T202	600 Min.-2400 Max.	600 Min.-2400 Max.	600 Min.-2400 Max.	600 Min.-2400 Max.	7.0 percent
Penetration of Bituminous Materials (residue from distillation 77°F., 100 g., 5 sec.) 0.1 mm	T49	80–120	80–120	80–120	80–120	3.0 percent
Ductility of Bituminous Materials (77°F., cms.)	T51	100 Min.	100 Min.	100 Min.	100 Min.	None
Proportion of Bitumen Soluble in Trichlorethylene (percent min.)	T44	99.0 Min.	99.0 Min.	99.0 Min.	99.0 Min.	0.10 percent Below Min.
Water in Petroleum Products and Other Bituminous Materials (percent)	T55	0.2 Max.	0.2 Max.	0.2 Max.	0.2 Max.	0.1 Mill

*When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.

**In lieu of viscosity of residue, the Department, at its option, may specify penetration at 100 g; Ss at 25°C. (77°F.) of 80–120 for Grades RC-70, RC-250, RC-800, and RC-3000. However, in no case will both be required.

TABLE III—Medium Curing Products

Test	AASHTO Test Method	GRADES; REQUIREMENTS MC-70	MC-250	MC-800	MC-3000	Allowable Tolerance*
Flash Point with Tagliabue Open Cup (percent F.)	T79	100 Min.	150 Min.	150 Min.	150 Min.	15°F. Below
Kinematic Viscosity of Asphalt (at 140°F., cs.)	T201	70–140	250–500	800–1600	3000–6000	2.0 percent
Distillation of Cut-Back Asphalt Products (percent of total distillate to 680°F.):						
to 437°F.	T78	20 Max.	0–10	.....	.....	1.0
to 500°F.		20–60	15–55	35 Max.	15 Max.	1.0
to 600°F.		65–90	60–87	45–80	15–75	1.0
Residue from distillation to 680°F. (volume percent by difference)		55 Min.	67 Min.	75 Min.	80 Min.	1.0
Tests on residue from distillation:						
Absolute viscosity at 60°C. (140°F.) poises**	T202	300 Min.-1200 Max.	300 Min.-1200 Max.	300 Min.-1200 Max.	300 Min.-1200 Max.	7.0 percent
Penetration of Bituminous Materials (residue from distillation 77°F., 100 g., 5 sec.)	T49	120–250	120–250	120–250	120–250	3.0 percent
Ductility of Bituminous Materials (77°F., cms.)	T51	100 Min.	100 Min.	100 Min.	100 Min.	None
Proportion of Bitumen Soluble in Trichlorethylene (percent min.)	T44	99.0 Min.	99.0 Min.	99.0 Min.	99.0 Min.	0.10 percent Below Min.
Water in Petroleum Products and Other Bituminous Materials (percent)	T55	0.2 Max.	0.2 Max.	0.2 Max.	0.2 Max.	0.1 Mill

*When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.

**In lieu of viscosity of residue, the Department, at its option, may specify penetration at 100 g; Ss at 25°C. (77°F.) of 120–250 for Grades MC-70, MC-250, MC-800, and MC-3000. However, in no case will both be required.

TABLE IV—Slow Curing Products

Test	AASHTO Test Method	GRADES; REQUIREMENTS SC–70	SC–250	SC–800	SC–3000	Allowable Tolerance*
Flash Point (C.O.C.) °F.	T48	150 Min.	175 Min.	200 Min.	225 Min.	15°F. below
Kinematic Viscosity at 140°F., cs.	T201	70–140	250–500	800–1600	3000–6000	2.0 Percent
Distillation:						
Total Dist. to 680°F., Vol. Percent	T78	10–30	4–20	2–12	5 Max.	1.0
Kinematic Viscosity at 140°F., S.	T201	4–70	8–100	20–160	40–350	1.5 Percent
Ductility of Asphalt Residue at 77°F., cm.	T51	100 Min.	100 Min.	100 Min.	100 Min.	None
Solubility in Trichlorethylene, Percent	T44	99.0 Min.	99.0 Min.	99.0 Min.	99.0 Min.	0.10% below Min.
Water in Petroleum Products and Other Bitum. Matls., Percent	T55	0.5 Max.	0.5 Max.	0.5 Max.	0.5 Max.	0.1 Mill

*When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limits, whichever is applicable.

Liquid asphalts not conforming to the requirements of Tables II, III, and IV will be assessed demerits in accordance with the graduated increments of the following schedule. Attention is directed to subsection 109.02, "Scope of Payment," where demerits will be evaluated for damages sustained by reason of any noncompliance.

AASHTO Test Method	Increment	Demerits (each increment of noncompliance)
T48	5 degrees below min.	1
T79	5 degrees below min.	1
T202	RC or MC–70, 4 poises*	1
T202	RC or MC–250, 8 poises*	1
T202	RC or MC–800, 16 poises*	1
T202	RC or MC–3000, 32 poises*	1
T201	RC or MC or SC–70, 2 centistokes*	1
T201	RC or MC or SC–250, 10 centistokes*	1
T201	RC or MC or SC–800, 50 centistokes*	1
T201	RC or MC or SC–3000, 100 centistokes*	1
T78	5% below min. or above max., per fraction	1
T49	0.1 millimeter above max.	1
T49	0.1 millimeter below min.	1
T51	5 centimeter below min.	2
T51	0.01 below min.	1
T703	0.1% above max.	1

*Above max. or below min.

703.03.04 Emulsified Asphalt. Emulsified asphalt shall conform to the requirements of Tables V and VI for the type and grade specified when tested in accordance with AASHTO as is enumerated.

TABLE V—Specifications for Cationic Emulsified Asphalt

Test	AASHTO Test Method	GRADE; REQUIREMENTS — Rapid Setting			Medium Setting		Slow Setting		Allowable Tolerances
		CRS-1	CRS-2	CRS-2h	CMS-2	CMS-2h	CSS-1	CSS-1h	
Test on Emulsion:[1]									
Furol Viscosity at 77°F., sec.	T59	.....	.....	.....	.....	.....	20–100	20–100	NONE
Furol Viscosity at 122°F., sec.	T59	20–100	100–400	75–400	50–450	50–450	.....	.....	NONE
Settlement, 5 days,[2] percent difference	T59	5—	5—	5—	5—	5—	5—	5—	5.0 percent
Sieve Test (Retained on No. 20) percent[3]	T59	0.10—	0.10—	0.10—	0.10—	0.10—	0.10—	0.10—	0.03 percent
Aggregate Coating—Water Resistance Test[4]	T59	.....	.....	.....	.....	.....	.....	.....	.....
Dry Agregate (Job) percent Coated	.....	.....	.....	.....	80+	80+	.....	.....	NONE
Wet Aggregate (Job) percent Coated	.....	.....	.....	.....	60+	60+	.....	.....	NONE
Cement Mixing Test, percent	T59	.....	.....	.....	.....	.....	2—	2—	NONE
(Particle Charge Test)	T59	Positive	Positive	Positive	Positive	Positive	.....	.....	NONE
pH	.....	.....	.....	.....	.....	.....	6.7—	6.7—	NONE
Distillation Residue, percent by Weight	T59	60+	65+	65+	65	65	57+	57+	1.0
Oil Distillate,[5] percent by volume of Emulsion	T59	3—	3—	3—	12	12—	.....	.....	NONE
Test on Residue:									
Penetration, 77°F., 100 g., 5 sec.	T49	100–250	100–250	60–100	100–250	40–90	100–250	40–90	1 unit up to 100; 3 percent from 100 up
Solubility in Trichlorethylene	T44	97.5	97.5	97.5	97.5	97.5	97.5	97.5	0.10 percent below min.
Ductility, 77°F., cm.	T51	40+	40+	40+	40+	40+	40+	40+	NONE

[1]All tests shall be performed within thirty (30) days from the date of emulsion shipment.

[2]The test requirement for settlement may be waived when the emulsified asphalt is used in less than five (5) days; or the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than five (5) days.

[3]Except that distilled water is used instead of sodium oleate solution.

[4]Calcium carbonate shall not be added to the job aggregate when making the aggregate coating-water resistance test.

[5]Volume of oil distillate may be determined by reading on the graduated cylinder which is used to collect total distillate.

TABLE VI—Specifications for Anionic Emulsified Asphalts

Test	AASHTO Test Method	GRADE; REQUIREMENTS — Rapid Setting RS–1	Rapid Setting RS–2	Medium Setting MS–2	Slow Setting SS–1	Slow Setting SS–1h	Allowable Tolerances
Test on Emulsion:[1]							
Furol Viscosity at 77°F., sec.	T59	20–100	.....	100+	20–100	20–100	NONE
Furol Viscosity at 122°F., sec.	T59	.....	75–400	.....	.....	.....	NONE
Residue from Distillation, percent by Weight	T59	57+	62+	62+	57+	57+	1.0
Settlement, 5 days, percent difference	T59	5	5	5	5	5	5 percent
Demulsibility:							
35 ml. of 0.02 N. $CaCl_2$ percent	T59	60+	50+	.....	.....	.....	5 percent
50 ml. of 0.10 N. $CaCl_2$ percent	T59	.....	.....	30—	.....	.....	5 percent
Sieve Test (Retained on No. 20), percent	T59	0.10—	0.10—	0.10—	0.10—	0.10—	0.03 percent
Cement Mixing Test, percent	T59	.....	.....	.....	2.0—	2.0—	0.2 percent
Tests on Residue:							
Penetration, 77°F., 100 g., 5 sec.	T49	100–200	100–200	100–200	100–200	40–90	1 unit up to 100; 3 percent from 100 up
Solubility in Trichlorethylene, percent	T44	97.5+	97.5+	97.5+	97.5+	97.5+	0.10 percent below min.
Ductility, 77°F., cms.	T51	40+	40+	40+	40+	40+	NONE

[1]All tests shall be performed within thirty (30) days from the date of emulsion shipment.

Emulsified asphalt not conforming to the requirements of Tables V and VI will be assessed demerits in accordance with the graduated increments of the following schedule. Attention is directed to subsection 109.02, "Scope of Payment," where demerits will be evaluated for damages sustained by reason of any noncompliance.

AASHTO Test Method	Increment	Demerits (each increment of noncompliance)
T59 (Furol Viscosity at 77°F., and at 122°F.)	2 seconds above max. or below min.	1
T59 (Settlement, 5 days, percent difference)	1 percent above max.	1
T59 (Sieve test, percent max.)	0.1 percent above max.	1
T59 (Cement mixing test)	0.5 percent above max.	1
T59 (Particle charge test)	Negative charge	21
T49 (Penetration, 77°F., 100 g., 5 sec.)	0.1 millimeter above max. or below min.	1
T44 (Solubility)	0.01 below min.	1
T51 (Ductility, 77°F., cm.)	5 centimeters below min.	2

SECTION 704

BASE AGGREGATES

SCOPE

704.01.01 Materials Covered. This specification covers the quality and size of mineral materials used in base course.

REQUIREMENTS

704.02.01 General. The mineral aggregate shall be the product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) That character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

The mineral aggregate shall be clean, hard, durable, free from frozen lumps, deleterious matter, and harmful adherent coatings.

704.02.02 Deficiencies. If the product of a deposit is deficient in material passing the No. 4 sieve, filler from other approved deposits may be added at the crushing and screening plants. This is not to be construed as a waiver of any of the requirements contained herein.

704.02.03 Plastic Limits. When specified, aggregates shall conform to the applicable requirements of the following table:

TABLE I

Percentage by Weight *Passing 200 Sieve	Plasticity Index Maximum
0.1 to 3.0	15
3.1 to 4.0	12
4.1 to 5.0	9
5.1 to 8.0	6
8.1 to 11.0	4
11.1 to 15.0	3

*Test Method No. Nev. T206.

PHYSICAL PROPERTIES AND TESTS

704.03.01 Drain Backfill. This aggregate shall conform to one (1) of the following grading requirements:

Sieve Size	Percentage by Weight Passing Sieve		
	Type 1	Type 2	Type 3
2 Inch	100	-----	-----
1½ Inch	90–100	-----	-----
1 Inch	-----	100	-----
¾ Inch	50–80	90–100	-----
⅜ Inch	-----	20–55	100
No. 4	24–40	0–10	60–90
No. 16	10–24	-----	26–60
No. 100	0–4	0–4	0–4
No. 200	0–2	0–2	0–2

Unless otherwise specified in the contract documents the Contractor may use either Type 1, 2, or 3.

Source Requirement Test (all types):

Test	Test Method	Requirement
Percentage of Wear (500 Rev.)	Nev. T233	37 Percent Max.

704.03.02 Type 1 Class A Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1½ Inch	100
1 Inch	80–100
No. 4	30–65
No. 16	15–40
No. 200	2–12

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	-----
Fractured Faces	Nev. T230	35 Percent Min.
Plasticity Index	Nev. T212	Table 1
Liquid Limit	Nev. T210	35 Max.

Source Requirement Tests	Test Method	Requirements
Resistance (R Value)	Nev. T115	70 Min.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

704.03.03 Type 1 Class B Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1½ Inch	100
1 Inch	80–100
No. 4	30–65
No. 16	15–40
No. 200	2–12

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	15 Percent Min.
Plasticity Index	Nev. T212	Table 1
Liquid Limit	Nev. T210	35 Max.

Source Requirement Tests	Test Method	Requirements
Resistance (R Value)	Nev. T115	70 Min.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

704.03.04 Type 2 Class A Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1 Inch	100
3/4 Inch	90–100
No. 4	35–65
No. 16	15–40
No. 200	2–10

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	50 Percent Min.
Plasticity Index	Nev. T212	Table 1
Liquid Limit	Nev. T210	35 Max.

Source Requirement Tests	Test Method	Requirements
Resistance (R Value)	Nev. T115	78 Min.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

704.03.05 Type 2 Class B Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1 Inch	100
3/4 Inch	90–100
No. 4	35–65
No. 16	15–40
No. 200	2–10

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	35 Percent Min.
Plasticity Index	Nev. T212	Table 1
Liquid Limit	Nev. T210	35 Max.

Source Requirement Tests	Test Method	Requirements
Resistance (R Value)	Nev. T115	70 Min.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

704.03.06 Type 3 Class A Aggregate. All requirements will be specified in the special provisions.

704.03.07 Type 3 Class B Aggregate. All requirements will be specified in the special provisions.

704.03.08 Aggregate for Portland Cement Treated Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1 Inch	100
3/4 Inch	90–100
No. 4	35–75
No. 16	15–45
No. 200	2–15

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Sand Equivalent	Nev. T227	20 Min.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

SECTION 705

AGGREGATES FOR BITUMINOUS COURSES

SCOPE

705.01.01 Materials Covered. This specification covers the quality and size of local mineral materials and commercial mineral fillers used in bituminous base and surface courses.

REQUIREMENTS

705.02.01 General. The mineral aggregate shall be the product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

The mineral aggregate shall be clean, hard, durable, free from frozen lumps, deleterious matter, and harmful adherent coatings.

The following requirement shall apply to all material sources proposed for use in the production of aggregates for bituminous products, except those material sources designated in the special provisions as being acceptable sources for the production of said aggregates.

Source Requirement Tests:

Test	Test Method	Requirement
Durability of Compacted Bituminous Mixtures (Not applicable when using Liquid Asphalts)	Nev. T320A	25 Percent Max.

The following requirements shall apply to all mix designs required in accordance with subsection 401.02.01 of these specifications.

Mix Design Tests (Plantmix and Roadmix Bituminous Base and Surface Aggregates, Types 1, 2, 3, and 4):

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	.....
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	50 Percent Min. Type 2, 35 Percent Min. for Types 1 and 3
Plasticity Index	Nev. T212	6 Percent Max.
Liquid Limit	Nev. T210	35 Percent Max.
Percent Durability Loss of Compacted Bituminous Mixtures (Not applicable when using Liquid Asphalts)	Nev. T320A	25 Percent Max.
Percent Air Voids of Compacted Bituminous Mixture	Nev. T323A	3 Percent Min., 6 Percent Max.

Test	Test Method	Requirements
Stripping Test	Nev. T209	Satisfactory
Stabilometer Value (Types 1 and 2)	Nev. T303	37 Min.
Stabilometer Value (Types 3 and 4)	Nev. T303	30 Min.
Moisture Vapor Susceptibility (Stabilometer Value)	Nev. T312	25 Min.
Swell Test	Nev. T304	0.030″ Max.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

Mix Design Tests (Plantmix Bituminous Open-Graded Surface Aggregate):

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	.....
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	90 Percent Min.
Stripping Test	Nev. T209	Satisfactory
Swell Test	Nev. T304	0.030″ Max.
Percentage of Wear (500 Rev.)	Nev. T233	37 Percent Max.
Percent Durability Loss of Compacted Bituminous Mixtures	Nev. T320A	25 Percent Max.

All material betwen the sizes of ten (10) inches in largest dimension and larger than the maximum size specified for a given product, shall be crushed and incorporated into that specified finished product. Producing other products simultaneously by "bleeding off" aggregates is strictly prohibited.

705.02.02 Deficiencies. If the product of any deposit is deficient in the fraction passing the No. 4 sieve, additional filler from other approved deposits meeting the physical requirements may be added. The added material shall be fed to the drier in a uniform manner from a separate stockpile. If the added material is a commercial mineral filler, it shall be uniformly fed directly to the plant. This is not to be construed as a waiver of any of the requirements contained herein.

PHYSICAL PROPERTIES AND TESTS

705.03.01 Plantmix and Roadmix Bituminous Base and Surface Aggregate, Types 1, 2, and 3. The aggregate shall conform to the following requirements:

	Percentage by Weight Passing Sieve		
Sieve Size	Type 1	Type 2	Type 3
1 Inch	100	100	.....
3/4 Inch	90–100	90–100	.....
1/2 Inch	.....	.....	100
3/8 Inch	63–85	63–85	85–100
No. 4	45–65	45–63	50–75
No. 10	.....	30–44	32–52
No. 16	20–40	.....	.....
No. 40	.....	16–24	16–30
No. 200	3–9	3–9	3–10

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	50 Percent Min. for Type 2, 35 percent Min. for Types 1 and 3
Plasticity Index	Nev. T212	6 Percent Max.
Liquid Limit	Nev. T210	35 Percent Max.

Source Requirement Tests	Test Method	Requirements
Stripping Test	Nev. T209	Satisfactory
Stabilometer Value (Types 1 and 2)	Nev. T303	37 Min.
Stabilometer Value (Type 3)	Nev. T303	30 Min.
Moisture Vapor Susceptibility (Stabilometer Value)	Nev. T312	25 Min.
Swell Test	Nev. T304	0.030″ Max.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

705.03.02 Plantmix Surface Aggregate, Type 4. The combined aggregates shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1/2 Inch	100
3/8 Inch	85–100
No. 4	50–75
No. 16	20–45
No. 200	3–10

Project Control Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	90 Percent Min.
Plasticity Index	Nev. T212	6 Percent Max.
Liquid Limit	Nev. T210	30 Percent Max.

Source Requirement Tests	Test Method	Requirements
Stripping Test	Nev. T209	Satisfactory
Stabilometer Value	Nev. T303	30 Min.
Moisture Vapor Susceptibility (Stabilometer Value)	Nev. T312	30 Min.
Swell Test	Nev. T304	0.030″ Max.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

705.03.03 Plantmix Bituminous Open-Graded Surface Aggregate. The aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve	
	1/2 Inch Size	3/8 Inch Size
1/2 Inch	100	100
3/8 Inch	90–100	95–100
No. 4	35–55	40–65
No. 16	5–18	12–22
No. 200	0–3	0–4

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	90 Percent Min.

Source Requirement Tests	Test Method	Requirements
Stripping Test	Nev. T209	Satisfactory
Swell Test	Nev. T304	0.030″ Max.
Percentage of Wear (500 Rev.)	Nev. T233	37 Percent Max.

705.03.04 Commercial Mineral Filler. Commercial mineral filler shall conform to the requirements of AASHTO Designation M216, Type 1, Grade B.

705.03.05 Screenings. The screenings shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve	
	1/2 Inch Size	3/8 Inch Size
1/2 Inch	100	.....
3/8 Inch	90–100	100
No. 4	15–35	20–45
No. 16	0–4	0–6
No. 200	0–2	0–2

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	90 Percent Min.

Source Requirement Tests	Test Method	Requirements
Stripping Test	Nev. T209	Satisfactory
Percentage of Wear (500 Rev.)	Nev. T233	37 Percent Max.

705.03.06 Sand Blotter. The sand shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1/2 Inch	100
No. 4	90–100
No. 16	30–75
No. 200	0–12

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Organic Impurities	Nev. T498	.....

SECTION 706

AGGREGATES FOR PORTLAND CEMENT PRODUCTS

SCOPE

706.01.01 Materials Covered. This specification covers the quality and size of aggregates used in Portland cement products.

REQUIREMENTS

706.02.01 General. The mineral aggregate shall be the product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

Before beginning concrete work, the Contractor shall submit in writing to the Engineer the proposed concrete mix design indicating the proportions of cement, water, admixtures, and the gradation of the primary aggregate nominal sizes which he proposes to furnish. The gradation shall consist of the gradation for each individual size, and the proposed proportions of each individual size, combined mathematically with the fine aggregate to indicate one (1) proposed gradation. Such gradation shall meet the grading requirements shown in the following table (not applicable to lightweight concrete):

Grading Limits of Combined Aggregates

Sieve Size	Percent Passing	
	1½" Max.	¾" Max.
2	100	.....
1½	87–100	.....
1	65–90	100
¾	48–82	80–100
⅜	39–57	46–70
4	30–45	34–50
8	23–38	24–42
16	15–33	17–34
30	8–24	10–25
50	4–13	5–15
100	1–5	2–7
200	0–3	0–3

Should the Contractor change his source of supply, he shall submit in writing to the Engineer the new gradations before their intended use.

PHYSICAL PROPERTIES AND TESTS

706.03.01 Coarse Aggregate. The aggregate shall conform to the following requirements:

Sieve Size	PERCENTAGE BY WEIGHT PASSING SIEVE						
	SIZE NO. 3 (2″ to 1″)	SIZE NO. 4 (1½″ to ¾″)	SIZE NO. 7 (½″ to No. 4)	SIZE NO. 57 (1″ to No. 4)	SIZE NO. 67 (¾″ to No. 4)	SIZE NO. 357 (2″ to No. 4)	SIZE NO. 467 (1½″ to No. 4)
2½ Inch	100	-------	-------	-------	-------	100	-------
2 Inch	95–100	100	-------	-------	-------	95–100	100
1½ Inch	35–70	90–100	-------	100	-------	95–100	
1 Inch	0–15	20–55	-------	95–100	100	35–70	-------
¾ Inch	-------	0–15	100	-------	90–100	-------	35–70
½ Inch	0–5	-------	90–100	25–60	-------	10–30	-------
⅜ Inch	-------	0–5	40–70	-------	20–55	-------	10–30
No. 4	-------	-------	0–15*	0–10*	0–10*	0–5	0–5

*Not more than five (5) percent shall pass No. 8 sieve.

NOTE: Sizes No. 357 and No. 467 shall each be split into two (2) sizes. Size No. 357 shall be furnished in stockpile or bunker in sizes No. 3 (2″ to 1″) and size No. 57 (1″ to No. 4). Size No. 467 shall be furnished in stockpile or bunker in size No. 4 (1½″ to ¾″) and size No. 67 (¾″ to No. 4). The two (2) sizes shall be uniformly combined at the mixing plant to comply with the grading requirements of sizes No. 357 and No. 467 respectively.

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Material Passing 200 Sieve	Nev. T206	1 Percent Max.
Percentage of Wear (100 Rev.)	Nev. T233	10 Percent Max.
Percentage of Wear (500 Rev.)	Nev. T233	50 Percent Max.
Soundness (5 Cycles, Sodium Sulfate)	Nev. T470	12 Percent Max. Loss
Clay Lumps	Nev. T490	0.3 Percent Max.
Cleanness Value	Nev. T228	71 Min.

Thin or elongated pieces (length greater than five (5) times maximum thickness) shall not exceed fifteen (15) percent by weight.

706.03.02 Lightweight Aggregates. These aggregates shall conform to the following requirements:

	PERCENTAGE BY WEIGHT PASSING SIEVE			
Sieve Size	Fine Natural	Fine Lightweight	1" Size Coarse	3/4" Size Coarse
1 Inch	.....	.....	95–100	100
3/4 Inch	.....	.....	.....	90–100
1/2 Inch	.....	.....	25–60	.....
3/8 Inch	100	100	.....	20–60
No. 4	95–100	85–100	0–10	0–10
No. 16	45–80	40–80	.....	.....
No. 50	10–35	10–35	.....	.....
No. 100	2–12	5–25	.....	.....
No. 200	0–5	.....	.....	.....

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above (a)
Sampling	Nev. T200	.....
Unit Weight (loose oven dry)	Nev. T119	Fine Agg.—70 lb. cu. ft. Max. (b) Coarse Agg.—55 lb. cu. ft. Max. (b) Comb. Fine and Coarse—65 lb. cu. ft. Max. (b)
Organic Impurities	Nev. T498	Satisfactory (c)
Clay Lumps	Nev. T490	2 Percent Max.
Test for Staining Materials	Nev. T488	Satisfactory (d)
Mortar Making Properties of Sand	Nev. T472	95 Percent Min. (e)

(a) With the following exceptions: The weight of the test sample for the fine lightweight aggregate shall be in accordance with Table III, and the aggregate when mechanically sieved shall be sieved for only five (5) minutes. The test sample for coarse aggregate shall consist of no less than one-tenth (0.1) cu. ft. of the material used for the determination of unit weight.

TABLE III
Weight of Sieve Test Sample for Fine Lightweight Aggregates

Nominal Weight of Aggregate Lbs. Per Cubic Foot	Weight of Test Sample, Grams
25–35	150
35–45	200
45–55	250
55–65	300
65–70	350

(b) The unit weight of successive shipments of lightweight aggregate shall not differ by more than ten (10) percent from that of the sample submitted for acceptance tests.

(c) Aggregates tested and showing color darker than the standard shall be rejected unless it can be demonstrated that the discoloration is due to small quantities of materials not harmful to the concrete.

(d) Aggregates tested and showing stain darker than "heavy stain" (stain index of eighty (80) or darker shall be tested by chemical procedure, and aggregates that contain one and five-tenths (1.5) mg. or more of ferric oxide (Fe_2O_3) per two hundred (200) gram sample shall be rejected for use.

(e) Fine aggregate failing in the test for organic impurities (Nev. T498) may be used provided that when tested for effect and organic impurities on strength of mortar, the relative strength at seven (7) and twenty-eight (28) days calculated in accordance with (Nev. T472) is not less than ninety-five (95) percent.

706.03.03 Fine Aggregate. This aggregate shall conform to the following requirements:

Sieve Size	Percentage by Weight Passing Sieve
3/8 Inch	100
No. 4	95–100
No. 16	45–80
No. 50	10–35
No. 100	2–12
No. 200	0–5

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Soundness (5 Cycles, Sodium Sulfate)	Nev. T470	10 Percent Max. Loss
Clay Lumps	Nev. T490	1 Percent Max.
Lightweight Pieces in Aggregate	Nev. T487	1 Percent Max.
Percentage of Particles of Less Than 1.95 Sp. Gr.	Nev. T486	3 Percent Max.
Organic Impurities	Nev. T498	Satisfactory (a)
Mortar Making Properties	Nev. T472	95 Percent Min. (b)
Sand Equivalent	Nev. T227	71 Min.

(a) Aggregates tested and showing color darker than the standard shall be rejected unless they pass the "Mortar Making Properties" test (Nev. T472).

(b) This test shall only be required should samples of fine aggregate fail to

pass the organic impurities test. Fine aggregate failing in the test for organic impurities (Nev. T498) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at seven (7) and twenty-eight (28) days calculated in accordance with Nev. T472 is not less than ninety-five (95) percent.

706.03.04 Grout and Mortar Sand. At the Contractor's option, sand for grout and mortar shall conform to either of the following requirements:

Sieve Size	Percentage by Weight Passing Sieve
3/8 Inch	100
No. 4	95–100
No. 16	45–80
No. 50	10–35
No. 100	2–12
No. 200	0–5

or

Sieve Size	Percentage by Weight Passing Sieve*
No. 4	100
No. 8	95–100
No. 16	70–100
No. 30	40–75
No. 50	20–50
No. 100	10–25
No. 200	0–10

*When lightweight, natural, or manufactured sand fails the gradation limits specified above, it may be used provided the mortar can be prepared to comply with the aggregate ratio, water retention, and compressive strength requirements of the property specification of ASTM Specification C270 for mortar for unit masonry.

At the Contractor's option, coarse aggregate for grout shall conform to either of the following requirements:

Sieve Size	Percentage by Weight Passing Sieve	
	Size No. 8	Size No. 89
1/2 Inch	100	100
3/8 Inch	85–100	90–100
No. 4	10–30	20–55
No. 8	0–10	5–30
No. 16	0–5	0–10
No. 30	-----	0–5

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	-----
Organic Impurities (sand)	Nev. T498	Satisfactory (a)
Soundness (Coarse Aggregate) (5 Cycles, Sodium Sulfate)	Nev. T470	12 Percent Maximum Loss
Soundness (Fine Aggregate) (5 Cycles, Sodium Sulfate)	Nev. T470	10 Percent Maximum Loss
Mortar Making Properties (sand)	Nev. T472	95 Percent Minimum (b)

(a) Aggregates tested and showing color darker than the standard shall be rejected unless they pass the "Mortar Making Properties" test (Nev. T472).

(b) This test shall only be required should samples of sand fail to pass the "Organic Impurities" test (Nev. T498). Sand failing in the test for organic impurities may be used provided that when tested for effect of organic impurities on mortar strength, the relative strength at seven (7) and twenty-eight (28) days calculated in accordance with Nev. T472 is not less than ninety-five (95) percent.

706.03.05 Stone for Masonry and Riprap. This stone shall conform to the following requirements:

Source Requirement Tests	Test Method	Requirements
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.
Specific Gravity	Nev. T111	2.5 Min.

SECTION 707

JOINT MATERIAL

SCOPE

707.01.01 Material Covered. This specification covers the quality requirements for poured filler, preformed fillers, and resilient and rubber type gaskets used in the construction of bridges, culverts, sidewalks, etc.

PHYSICAL PROPERTIES AND TESTS

707.03.01 Joint Fillers. Preformed fillers for joints shall conform to the requirements of ASTM D1751, Fiber Type, and shall be punched to admit the dowels where called for on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise authorized by the Engineer. When the use of more than one (1) piece is authorized for a joint, the abutting ends shall be fastened securely and held in place by stapling or other positive fastening satisfactory to the Engineer.

707.03.02 Rubber Gaskets. The ring gaskets shall conform to the requirements of AASHTO M198.

707.03.03 Waterstops. Waterstops shall conform to the following requirements:

(a) Natural Rubber—

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D412	Tensile strength 3,500 lbs. Min. p.s.i.—Elongation at breaking of 550 percent. Unit stress (300 percent) 1,100 lbs. p.s.i. Min. Unit stress (500 percent) 2,800 lbs. p.s.i. Min.
Test for Accelerated Aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D572	After 7 days in air at 150° (±2°)F. or after 48 hours in oxygen at 158° (±2°)F. and 300 lbs. p.s.i., the tensile strength and elongation shall not be less than 65 percent of the original.
Test for Indentation of Rubber by Means of a Durometer	ASTM D2240	55 to 65 (hardness)

Natural rubber waterstops shall be manufactured from a stock composed of a high grade compound made exclusively from new plantation rubber reinforced carbon black, zinc oxide, accelerators, antioxidants, and softeners. This compound shall contain not less than seventy-two (72) percent by volume of new plantation rubber.

(b) Synthetic Rubber—

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D412	Tensile strength 2,500 lbs. p.s.i. Min. Elongation at breaking of 425 percent.
Testing for Accelerated Aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D572	After 7 days in air at 158° (±2°)F. or after 48 hours in oxygen at 158° (±2°)F. and 300 lbs. p.s.i., the tensile strength and elongation shall not be less than 65 percent of the original.
Test for Indentation of Rubber by Means of a Durometer	ASTM D2240	50 to 70 (hardness)

(c) Polyvinyl Chloride—

Test	Test Method	Requirements
Polyvinyl Chloride Waterstops	Corps of Engr. CRD-C572	Compliance of paragraph 6

707.03.04 Pourable Joint Sealer. The sealant shall consist of a two (2) component polyurethane sealant which will withstand up to plus or minus twenty-five (25) percent movement.

When tested in accordance with Test Method No. Nev. T444, the sealant shall conform to the following requirements:

Modulus at 150 percent elongation	8–75 p.s.i.
Width of sealant after 7 days extension and one hour recovery	$2\frac{1}{32}$ inch max.
Condition 24 hours after notching	Sealant must not fail completely in adhesion or cohesion.
Condition of water immersed specimen at 7 days	Notches or loss of bond $\frac{1}{4}$ inch, max.
Condition of specimen after 100 hours in Fadeometer	No more than slight checking or cracking
Grease cone penetration	4.5–12.0 millimeters

The sealant shall be self-levelling but cure rapidly enough to avoid flow after application on grades up to fifteen (15) percent.

No material shall be used which has skinned over or which has settled in the container to the extent that it cannot be easily redispersed by hand stirring to

form a smooth uniform product. Each container shall be clearly labeled or each delivery of material in the tanks of two (2) component equipment shall be accompanied with a ticket showing the manufacturer's name, lot or batch number, date of manufacture, date of packaging, date, if any, beyond which the polyurethane sealant shall not be used without additional testing and approval, and manufacturer's instructions for use.

Polyethylene foam shall be commercial quality, with a continuous, impervious, glazed top surface, suitable for retaining the liquid polyurethane sealant in the joint while hardening.

A primer, furnished by the manufacturer of the sealant, shall be applied to the sides of the groove and to all exposed vertical surfaces in the joint prior to placing the polyurethane sealant. The primer shall be dry at time of placing the sealant. Contaminated primer shall be removed and replaced.

The sealant shall be machine mixed and placed with equipment which accurately proportions and mixes the two (2) components and extrudes the mixed material into the joint. Such equipment shall be of a type approved by the manufacturer of the sealant and all manufacturer's instructions shall be followed. Polyurethane liquid components which have been exposed to the atmosphere for more than twenty-four (24) hours shall not be used.

The Contractor shall furnish the Engineer with a Certificate of Compliance executed by the manufacturer of pourable joint sealer. Such certificate shall attest that the pourable joint sealer, as produced in the usual course of the manufacturer's trade, conforms to these specifications.

707.03.05 Asphalt Plank. Asphalt plank shall conform to the requirements of ASTM Designation D517 for plain asphalt plank.

707.03.06 Blank.

707.03.07 Joint Sealer for Weakened Plane Joints in Portland Cement Concrete Pavements. (a) Transverse Weakened Plane Joints. The joint sealant material shall be Dow Corning 888 Highway Joint Sealant, General Electric Silicone Highway Joint Sealant SCS 4403, Superior Products Superseal 888, or approved equal. Only silicone based products will be considered for approval.

(b) Longitudinal Weakened Plane Joints. At the Contractor's option, the sealant for longitudinal weakened plane joints may be the same material required in subparagraph (a) of this subsection, or the material shall conform to the following requirements:

The sealant shall be a single component hot poured elastomeric polymer joint sealer conforming to the requirements of ASTM Designation D3406 as to general requirements, physical properties, packing, and marking and sampling. Testing methods for physical requirements enumerated in ASTM Designation D3406 shall be in accordance with the requirements of ASTM Designation D3408.

All sealants shall be placed in accordance with the manufacturer's recommendations, two (2) copies of which shall be furnished to the Engineer not less than fourteen (14) days in advance of beginning joint sealing operations.

SECTION 708

CONCRETE AND CLAY PIPE AND DRAINS

SCOPE

708.01.01 Materials Covered. This specification covers the quality of clay pipe, nonreinforced concrete pipe, reinforced concrete pipe, bituminous fiber pipe, and corrugated polyethylene pipe used for culverts, siphons, pressure conduits, sewers, and storm drains, and the quality of perforated pipe used in underdrains.

PHYSICAL PROPERTIES AND TESTS

708.03.01 Reinforced Concrete Pipe. This pipe shall conform to the requirements of AASHTO M170 for the specified diameters and strength classes. Elliptical pipe shall be furnished where specified. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional.

Precast reinforced concrete end sections shall conform to the requirements of the cited specifications to the extent to which they apply.

708.03.02 Nonreinforced Concrete Pipe. This pipe shall conform to the requirements of AASHTO M86 for the specified diameters and strength classes.

708.03.03 Perforated Concrete Pipe. This pipe shall conform to the requirements of AASHTO M175 or to ASTM C444 for the specified diameters and strength classes.

708.03.04 Clay Pipe. This pipe shall conform to the requirements of AASHTO M65 for pipe with full circular cross section, for the specified diameter and strength class. When specified, the bell shall have integral spacer lugs to provide for an annular opening and self-centering feature.

708.03.05 Bituminous Fiber Pipe. This pipe shall conform to the requirements of AASHTO M177, ASTM D1861, or ASTM D1862.

708.03.06 Perforated Bituminous Fiber Pipe. This pipe shall conform to the requirements of AASHTO M177 for the specified diameters. Unless otherwise specified, either Type 1 or Type 2 couplings may be furnished.

708.03.07 Corrugated Polyethylene Pipe. Perforated and nonperforated corrugated polyethylene pipe shall conform to the requirements of AASHTO M252 and M294 for the specified diameters.

SECTION 709

METAL PIPE AND DRAINS

SCOPE

709.01.01 Material Covered. This specification covers the quality of metal pipes, metal arch pipes, metal end sections, structural plate pipe, and perforated metal pipe used for culverts, drainage structures, conduits, and underdrains.

PHYSICAL PROPERTIES AND TESTS

709.03.01 Corrugated Metal Pipe and Pipe Arches. These conduits and the coupling bands shall conform to the requirements of AASHTO M36 for the specified sectional dimensions and spelter coating. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

Special sections, such as elbows, tees, and wyes, for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to applicable requirements of AASHTO M36.

709.03.02 Bituminous Coated Corrugated Metal Pipe and Pipe Arches. These conduits and the coupling bands shall conform to the requirements of AASHTO M190 for the specified sectional dimensions, gages, and type of bituminous coating. Coupling bands shall be fully coated with bituminous material. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

Special sections, such as elbows and flared end sections, for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to the applicable requirements of AASHTO M190. Coating and invert paving shall be of the type specified. Coating shall be as required for Type A unless otherwise specified.

When bituminous coated metal pipe is specified for use, the Contractor may, at his option, furnish aluminized corrugated steel pipe, Type 2, conforming to the requirements of AASHTO Designation M36 in lieu of bituminous coated steel pipe.

709.03.03 Corrugated Aluminum Pipe. This pipe shall conform to the requirements of AASHTO M196.

709.03.04 Corrugated Metal Pipes for Downdrains. Downdrain flumes and pipe shall conform to the requirements of AASHTO M36. Type III inlets shall conform to the requirements of AASHTO M36. Type I and Type II inlets shall conform to the requirements of ASTM A93 except two (2) ounce coating shall be required. When specified, pipe, flumes, and inlets shall be bituminous coated conforming to the requirements of AASHTO M190. All anchor assemblies, hardware, and accessories shall conform to the requirements of ASTM A153 and ASTM A123.

709.03.05 Corrugated Metal Pipe for Underdrains. This pipe shall conform to the requirements of AASHTO M36, Type III for the specified diameters. Unless otherwise specified, any one (1) of the first three (3) classes shown may be furnished.

709.03.06 Bituminous Coated Corrugated Metal Pipe for Underdrains. This pipe shall conform to the requirements of AASHTO M36 and shall be coated with bituminous material to meet requirements of AASHTO M190, Type A coating, except that minimum coating thickness shall be three one-hundredths (0.03) inch. Coupling bands shall be full coated. The specified minimum diameter of perforations shall apply after coating.

709.03.07 Corrugated Aluminum Pipe for Underdrains. This pipe shall conform to the requirements of AASHTO M196 and M197.

709.03.08 Steel Structural Plate Pipe and Pipe Arches. This pipe shall conform to the requirements of AASHTO M167.

709.03.09 Aluminum Structural Plate Pipe and Pipe Arches. This pipe shall conform to the requirements of AASHTO M219. The aluminum structural plate pipe shall be designed in accordance with Division I, Section 12 of the AASHTO Standard Specifications for Highway Bridges, 1983 Edition and supplements thereto. The Contractor shall submit for approval two (2) copies of the longhand design notes, details, and all backup information relative to the adequacy of the design.

SECTION 710

STRUCTURAL STEEL

SCOPE

710.01.01 Material Covered. This specification covers the quality of structural steel used in highway structures.

REQUIREMENTS

710.02.01 Defects. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects. It shall have a smooth, uniform finish and shall be straightened in the mill before shipment.

Material shall be free from loose mill scale, rust pits, or other defects affecting its strength or durability.

The Engineer reserves the right to reject material which he deems unsuitable for the purpose intended even though the material meets the requirements of the mill tolerances.

710.02.02 Charpy V-notch Test. All steels used in and designated as main load carrying members subject to tensile stress, shall comply with all the requirements specified for charpy v-notch test in the various AASHTO designations for the steels involved. Sampling and testing procedures shall be in accordance with the requirements of the applicable AASHTO Temperature Zone Designation as shown on the contract documents, but not less than the requirements of Zone 2.

PHYSICAL PROPERTIES AND TESTS

710.03.01 Standard Steel. All steel for use in miscellaneous structures unless otherwise noted shall conform to the requirements of AASHTO M183 (ASTM A36).

710.03.02 High Strength Low Alloy Columbium-Vanadium Steel. This steel shall conform to the requirements of AASHTO M223 (ASTM A572) Grade 50, and shall be other than rimmed or capped steel.

710.03.03 High Strength Bolts. All bolts, nuts, and washers to be used in high-strength connections shall conform to Division II, Article 10.3.1.7 "High Strength Bolts," of the AASHTO Standard Specifications for Highway Bridges.

710.03.04 Stainless Steel Bolts. This steel shall conform to the requirements of ASTM A276.

710.03.05 Welded Seamless Steel Pipe. This steel shall conform to the requirements of ASTM A53, Grade B.

710.03.06 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes. This steel shall conform to the requirements of ASTM A500, Grade B.

710.03.07 Shear Stud Connectors. Shear stud connectors shall conform to the requirements of Division II, Article 10.3.1.9 of the current AASHTO Standard Specifications for Highway Bridges.

710.03.08 Pins and Rollers. This steel shall conform to the requirements of Division II, Article 10.3.2, Steel Forgings and Steel Shafting of the current AASHTO Standard Specifications for Highway Bridges, except pin nuts shall conform to subsection 710.03.01 of these special provisions.

710.03.09 Bolts. All bolts, nuts, and washers not intended for high-strength connections shall conform to ASTM A307.

710.03.10 Structural Steel. Unless otherwise noted on the plans, all structural steel for use in main load carrying members of bridge structures shall conform to the requirements of AASHTO M183 (ASTM A36) with Supplementary Requirement S2. Bridge elements typically not considered as main load carrying members include: crossframes, diaphragms, wind bracing, stiffeners, gussett plates, bearing plates, and expansion assemblies.

710.03.11 High Strength Low Alloy Steel. This steel shall conform to the requirements of AASHTO M222 (ASTM A588).

710.03.12 High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding. This steel shall conform to the requirements of AASHTO M244 (ASTM A514).

710.03.13 High-Yield-Strength Alloy Steel Plates, Quenched and Tempered for Pressure Vessels. This steel shall conform to the requirements of ASTM A517.

SECTION 711

ALUMINUM FOR BRIDGE RAIL

SCOPE

711.01.01 Material Covered. This specification covers the quality of aluminum alloy used in bridge rail.

PHYSICAL PROPERTIES AND TESTS

711.03.01 Aluminum Alloy for Pipe. This pipe shall conform to the requirements of ASTM B241 Alloy 6061–T6 or 6063–T6.

711.03.02 Aluminum Alloy Tubing. This tubing shall conform to the requirements of ASTM B221 Alloy 6061–T6 or 6063–T6.

711.03.03 Cast Aluminum Alloy. This alloy shall conform to the requirements of AASHTO M193.

711.03.04 Aluminum Alloy Shims. This alloy shall conform to the requirements of ASTM B209 Alloy 1100–0.

SECTION 712

MISCELLANEOUS METAL

SCOPE

712.01.01 Material Covered. This specification covers the type and quality of miscellaneous metals used in various highway construction.

PHYSICAL PROPERTIES AND TESTS

712.03.01 Steel Castings. This steel shall conform to the requirements of ASTM A27, Grade 65-35.

712.03.02 Gray Iron Castings. These castings shall conform to the requirements of ASTM A48, Class 40.

712.03.03 Malleable Castings. These castings shall conform to the requirements of ASTM A47, Grade 32510.

712.03.04 Blank.

712.03.05 Bronze Castings. These castings shall conform to the requirements of ASTM B22, Copper Alloy No. 863 (UNS No. C86300).

712.03.06 Welding Materials. Materials used for welding shall conform to the current American Welding Society Structural Welding Code and current AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

712.03.07 Steel Piles. This steel (''H'' Piles and Sheet Pilings) shall conform to the requirements of ASTM A36.

712.03.08 Steel Shell for Piles. This steel shall conform to the requirements of ASTM A252, Grade 2.

SECTION 713

REINFORCEMENT

SCOPE

713.01.01 Materials Covered. This specification covers the quality of bar steel, fabricated reinforcement and welded steel wire used in the reinforcement of concrete.

PHYSICAL PROPERTIES AND TESTS

713.03.01 Bar Steel Reinforcement. This steel shall conform to the applicable following requirements:

Test	Test Method	Requirements
Deformed Billet-Steel Bars for Concrete Reinforcement	ASTM A615	Grade 40, 60 (a)
Axle-Steel Deformed Bars for Concrete Reinforcement	ASTM A617	Grade 40, 60 (a)
Spiral Reinforcement	ASTM A615	Grade 60 (a)

(a) With the following exceptions: If reinforcing steel bars fail to meet the minimum unit stress when calculated on the basis of ASTM A615 or A617 the material may be considered acceptable if minimum specification requirements are satisfied by computing the unit stress "Section Area" method described in Test Method No. Nev. T484.

(b) The steel supplier shall furnish three (3) copies of certified mill test results for each heat of steel supplied to the project. Additionally two (2) thirty (30) inch samples of each size per heat shall also be furnished for testing. Field samples may also be tested from "extra" bars as required in subsection 505.02.02 of these specifications.

713.03.02 Fabricated Steel Bar or Rod Mats Reinforcement. This steel shall conform to the requirements of ASTM A184.

713.03.03 Welded Steel Wire Fabric Reinforcement. This steel shall conform to the requirements of ASTM A185.

713.03.04 Prestressing Steel. Prestressing steel shall be high-tensile wire conforming to ASTM Designation A421, high-tensile wire strand conforming to ASTM Designation A416, or uncoated high-strength steel bars conforming to the following requirements:

	Plan Bars		Deformed Bars
	Grade 145	Grade 160	Grade 150
Ultimate tensile strength, p.s.i.	145,000	160,000	150,000[6]
Yield Strength, p.s.i.	130,000[2]	140,000[2]	120,000[1,6]
Elongation, min. percent	4[3]	4[3]	7[4]
Reduction in area, min. percent	20[5]	20[5]	20[6,7]
Modulus of Elasticity at 70 percent of guaranteed ultimate strength, min. p.s.i.	25x10[6]	25x10[6]	25x10[6]

[1]Measured at two-tenths (0.2) percent offset.

[2]Measured at seven-tenths (0.7) percent extension under load method.

[3]Measured in twenty (20) bar diameters.

[4]Measured in ten (10) bar diameters or eight (8) inch minimum.

[5]Based on nominal area.

[6]Based on effective area which is determined from the bar weight less three and five-tenths (3.5) percent for the ineffective weight of the deformations.

[7]For deformed bars, the reduction of area shall be determined from a bar from which the deformations have been removed. Such a bar shall be machined no more than necessary to remove the deformations over a length of twelve (12) inches, and reduction will be based on the area of the machined portion.

Dimensions and Weights of High Strength Bars

Nominal Dia. In.[1]	Nom. Wt. Lb./ft.	Nom. Area In.[2]	Nom. Wt. Lb./ft.	Eff. Area In.[2]
5/8	.....	.....	0.98	0.28
3/4	1.50	0.44	1.49	0.42
7/8	2.04	0.60	.....	.....
1	2.67	0.78	3.01	0.85
1 1/8	3.38	0.99	.....	.....
1 1/4	4.17	1.23	4.49	1.25
1 3/8	5.05	1.48	5.56	1.58

[1]The maximum variation in diameter of a plain bar shall not exceed +0.030, —0.010 inch from the nominal diameter.

[2]The maximum variation in weight for deformed bars shall not exceed +3.0 percent or —2.0 percent of the nominal weight for the respective bar size.

Both plain and deformed bars shall show no evidence of cracking after being bent ninety (90) degrees around a pin. For bars five-eighths (5/8) inch diameter through one and one-eighth (1 1/8) inch diameter the pin diameter shall be six (6) times the bar diameter. For one and one-fourth (1 1/4) inch and one and three-eighths (1 3/8) inch diameter bars the pin diameter shall be eight (8) times the bar diameter.

The bend test shall be made when the steel is between sixty (60) degrees and eighty (80) degrees F. The bending apparatus shall provide a continuous and uniform application of force throughout the duration of the bending operation, unrestricted movement of the specimen at the points of contact, and close wrapping of the specimen around the pin or mandrel during the bending operation.

All bars in any individual member shall be of the same grade, unless otherwise permitted by the Engineer.

When bars are to be extended by the use of couplers, the assembled units shall have a tensile strength of not less than the manufacturer's minimum guaranteed ultimate tensile strength of the bars. Failure of any one (1) sample to meet this requirement will be cause for rejection of the heat of bars and lot of couplers. The location of couplers in the member shall be subject to approval by the Engineer.

Wires shall be straightened if necessary to produce equal stress in all wires or wire groups or parallel lay cables that are to be stressed simultaneously or when necessary to insure proper positioning in the ducts.

Where wires are to be button-headed, the buttons shall be cold formed symmetrically about the axis of the wires. The buttons shall develop the minimum guaranteed ultimate tensile strength of the wire. No cold forming process shall be used that causes indentations in the wire. Button-heads shall not contain wide open splits, more than two (2) splits per head, or splits not parallel with the axis of the wire.

Sampling and testing shall conform to the specifications of ASTM Designation A416 and ASTM Designation A421 and as specified below.

Samples from each size and each heat of prestressing bars, from each manufactured reel of prestressing steel strand, from each coil of prestressing wire, and from each lot of anchorage assemblies and bar couplers to be used shall be furnished for testing. With each sample of prestressing steel wires, bars, or strands furnished for testing, there shall be submitted a certification stating the manufacturer's minimum guaranteed ultimate tensile strength of the sample furnished.

All materials for testing shall be furnished by the Contractor at his expense. The Contractor shall have no claim for additional compensation in the event his work is delayed awaiting approval of the materials furnished for testing.

All bars of each size from each mill heat, all wire from each coil, and all strand from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each such lot can be accurately identified at the jobsite. Each lot of anchorage assemblies and bar couplers to be installed at the site shall be likewise identified. All unidentified prestressing steel, anchorage assemblies or bar couplers received at the site will be rejected.

The following samples of materials and tendons, selected by the Engineer from the prestressing steel at the plant or jobsite, shall be furnished by the Contractor to the Engineer well in advance of anticipated use:

(a) For wire, strand, or bars, one (1) five (5) foot long sample of each size shall be furnished for each heat and pack or reel.

(b) If the prestressing tendon is to be prefabricated, one (1) completely fabricated prestressing tendon five (5) feet in length for each size of tendon shall be furnished, including anchorage assemblies. If the prestressing tendon is to be assembled at the jobsite, sufficient wire or strand and end fittings to make up one (1) complete prestressing tendon five (5) feet in length for each size of tendon shall be furnished, including anchorage assemblies.

(c) If the prestressing tendon is a bar, one (1) five (5) foot length complete with one (1) end anchorage shall be furnished and in addition, if couplers are to be used with the bar, two (2) four (4) foot lengths of bar equipped with one (1) coupler and fabricated to fit the coupler shall be furnished.

Before being allowed for use, the proposed prestressing system must have prior approval by the Engineer. Approval of new prestressing systems will be contingent on prequalification testing by the Contractor, at his expense, of complete tendon assemblies as proposed for use and the submittal of written information as may be requested by the Engineer.

When prestressing systems have been previously tested and approved for

Department of Transportation's projects, complete tendon samples need not be furnished, provided there is no change whatsoever in the materials, design, or details previously approved. Working drawings shall contain an identification of the project on which approval was obtained, otherwise sampling will be required.

For prefabricated tendons, the Contract shall give the Engineer at least ten (10) days notice before commencing the installation of end fittings or the heading of wires. The Engineer will inspect end fittings installations and wire headings while such fabrication is in progress at the plant and will arrange for the required testing of the material to be shipped to the site.

No prefabricated tendon shall be shipped to the site without first having been released by the Engineer, and each tendon shall be tagged before shipment for identification purposes at the site. All unidentified tendons received at the site will be rejected.

Jobsite or site as referred to herein shall be considered to mean the location where the members are to be manufactured whether at the bridge site or a removed casting yard.

The release of any material by the Engineer shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

713.03.05 Cold-Drawn Steel Wire for Spiral Reinforcement. This steel shall conform to the requirements of ASTM A82.

SECTION 714

PAINT

SCOPE

714.01.01 Materials Covered. This specification covers the quality, color, and number of applications of paint used in painting the various materials of highway construction. Attention is directed to Section 715, "Galvanizing," for galvanized coatings.

REQUIREMENTS

714.02.01 Certificates. The Contractor shall furnish the Engineer with written certification that all required tests have been satisfactorily completed and that the materials thereof comply with all the requirements. Samples will be taken when required by the Engineer.

PHYSICAL PROPERTIES AND TESTS

714.03.01 Iron and Steel Use Items. The Contractor may choose from SSPC (Steel Structures Painting Council) Alkyd Paint Systems 2.00 or Phenolic Paint System 3.00 when metal rail, bridge or pedestrian rail and guardrail are specified to receive paint or when painting structural steel, miscellaneous iron and steel standards. The color of paint shall be as shown on the plans or specified in the special provisions. The use of lead base paint will not be allowed.

The Contractor shall submit to the Engineer for approval a letter indicating his choice of system, accompanied by certificates attesting that the ingredients chosen meet the applicable specifications and requirements prior to application of any paint.

714.03.02 Timber Use Items. Cattle guard wings, bridge railings, right of way markers, sign posts, and miscellaneous timber structures specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formula or Specification
Prime	1	White	Mixed Pigment Exterior Wood Primer	*TT-P-25 *TT-P-25
Intermediate (first coat after primer)	1	Cream	Titanium Zinc Oxide	*TT-P-102 Class B
Finish (second coat after primer	1	White	Titanium Zinc Oxide	*TT-P-102 Class B
Trim, Lettering and Indications (used when so indicated on plans)	1	Black	Titanium Zinc Oxide	*TT-P-61

*Federal specifications.

714.03.03 Concrete Use Items. Miscellaneous concrete specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formula or Specification
Finish	1	White	Water Thinned	Acrylic Resin or Synthetic Latex Alkyd Emulsion

714.03.04 Aluminum Use Items. Aluminum bridge railing and posts specified to receive paint shall be prepared for painting with a chemical conversion coating conforming to the requirements of Federal Specification MIL–C–5541. The coating shall be applied in accordance with the manufacturer's specifications and recommended sequence of operations.

The Contractor may use any of the paint systems specified for use on iron or steel in subsection 714.03.01 for painting aluminum, and shall submit to the Engineer for approval a letter indicating his choice of system as required for iron or steel.

SECTION 715

GALVANIZING

SCOPE

715.01.01 Material Covered. This specification covers the quality and thickness of galvanize used on various material when called for on the plans or designated in the specifications.

PHYSICAL PROPERTIES AND TESTS

715.03.01 Products One-eighth (1/8) Inch Thick and Thicker. Galvanizing of products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip shall conform to the requirements of ASTM Designation A123.

715.03.02 Rail Elements. All rail elements shall be galvanized in accordance with AASHTO Designation M180, Type 1.

715.03.03 Hardware. Bolts, nuts, washers, and fastenings shall be galvanized in accordance with the requirements of ASTM Designation A153.

715.03.04 Mechanical Galvanizing. In lieu of hot-dipped galvanizing as specified in these specifications, ferrous metals may be mechanically galvanized in accordance with ASTM Designation B695. Regardless of the method chosen, the coated product shall conform to the coating thickness, adherence, and quality requirements of AASHTO Designation M232.

SECTION 716

SIGN MATERIALS

SCOPE

716.01.01 Materials Covered. This specification covers the kind and quality of materials used in the construction and fabrication of "Construction Signs," "Temporary Signs," and "Permanent Signs."

REQUIREMENTS

716.02.01 General. The following materials shall conform to the requirements as noted:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505

716.02.02 Certificates. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Department. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

All materials shall be approved prior to use.

PHYSICAL PROPERTIES AND TESTS

716.03.01 Reflective Sheeting. The reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat outer surface (Type I), or spherical lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface (Type III). All sheeting shall be weather resistant and shall have a protected, precoated adhesive backing.

Color tolerance shall be within the limits of the FHWA Color Tolerance Charts. The instrumental testing restrictions noted on the FHWA Color Tolerance Charts relative to retroflective materials may be disregarded to the following extent:

An alternative to visual testing, instruments providing a system of diffuse illumination and unidirectional viewing may be used as a preliminary means of establishing that the colors meet the required CIE limits. In the event of any dispute concerning the results of instrumental testing, the visual test shall prevail.

The diffuse day color of the reflective sheeting shall conform to the requirements of the CIE Chromaticity Coordinate Limits hereinafter specified and shall be determined in accordance with ASTM Designation E97 "Standard Method of Test for 45 Deg. Directional Reflectance of Opaque Specimens by Filter Photometry." (Geometric characteristics must be confined to illumination incident within ten (10) degrees of and centered about a direction forty-five (45) degrees from the perpendicular to the test surface; viewing is within fifteen (15) degrees of and centered about the perpendicular to the test

surface. Conditions of illumination and observation must not be interchanged.) The standards to be used for reference shall be the Munsell Papers. Papers must be recently calibrated on a spectrophotometer.

The test instrument shall be one (1) of the following:

(a) Gardner multipurpose Reflectometer.

(b) Gardner Model AC–2a Color Difference Meter.

(c) Meeco Model V Colormaster.

(d) Hunterlab D25 Color Difference Meter.

The reflective sheeting shall include a precoated pressure sensitive adhesive or a tack free heat activated adhesive either of which shall be applied exactly or specified by the sheeting manufacturer to recommended, properly prepared flat surfaces without necessity of additional coats on the reflective sheeting or application surface.

Type I Reflective Sheeting

(a) Photometric Requirements. The reflective sheeting shall have the following minimum brightness values at two-tenths (0.2) degrees and five-tenths (0.5) degrees and one and five-tenths (1.5) degrees divergence expressed as average candlepower per foot-candle per square foot (candelas per lux per square meter) of material. Measurements shall be conducted in accordance with standard testing procedures for reflex-reflectors of Federal Specification L–S–300A, "Sheeting and Tape, Reflective, Nonexposed Lens Adhesive Backing," paragraph 4.47, or as amended.

Div. Ang. Inc. Ang.	Silver-White No. 1		
	.2°	.5°	1.5°
—4°	70	30	4
40°	14.5	8.5	1.5

	Red		
	.2°	.5°	1.5°
	14.5	7.5	1.0
	3.0	1.5	0.3

	Orange		
	.2°	.5°	1.5°
	25.0	13.5	1.5
	1.0	0.8	0.1

	Silver-White No. 2		
	.2°	.5°	1.5°
	80	41	4
	16.5	9.5	2.0

	Blue		
	.2°	.5°	1.5°
	4	2	0.6
	0.9	0.4	0.08

	Yellow		
	.2°	.5°	1.5°
	50.0	25.0	5.0
	11.5	7.0	1.5

	Green		
	.2°	.5°	1.5°
	9	4.5	1.0
	1.8	1.5	0.2

(b) Wet Performance. The wet performance measurements shall be conducted in accordance with standard rainfall tests specified in Federal Specification L–S–300A and the brightness of the reflective sheeting totally wet by rain shall not be less than ninety (90) percent of the preceding values.

(c) Color. The diffuse day color of Type I reflective sheeting shall conform to the following:

TYPE I—CIE Chromaticity Coordinate Limits

	x	y	x	y	x	y	x	y	(Y) Reflectance Limit Min.	(Y) Reflectance Limit Max.	Ref. Std. Munsell Papers
Silver-White Nos. 1 and 2	.320	.310	.360	.360	.338	.377	.300	.328	34.0	.....	5.1GY6.91/1.2
Yellow	.482	.450	.532	.465	.505	.494	.475	.485	29.0	40.0	1.25Y6/12
Red	.602	.317	.664	.336	.644	.356	.575	.356	8.0	11.0	8.2R3.78/14.0
Green	.140	.354	.179	.372	.147	.435	.120	.420	4.0	7.0	.65/BG2.84/8.45
Blue	.147	.075	.176	.091	.176	.151	.106	.113	1.0	2.4	5.8PB1.32/6.8
Orange	.535	.375	.535	.399	.582	.417	.607	.393	19.77	30.05	2.5YR5.5/14.0

(d) Lens Elements. The reflective sheeting shall possess stable and durable spherical lens elements which, following extraction, shall show no deterioration following submersion in a 5N solution of sulphuric acid (H_2SO_4) for thirty (30) minutes at seventy-two (72) degrees Fahrenheit (twenty-three (23) degrees Centigrade).

(e) Adhesive. The reflective sheeting shall include a precoated pressure sensitive adhesive or a tack-free heat activated adhesive, either of which may be applied without necessity of additional adhesive coats on the reflective sheeting or application surface.

The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solvents and shall be easily removed after accelerated storage for four (4) hours at one hundred fifty (150) degrees Fahrenheit (sixty-five (65) degrees Centigrade) under weight of two and five-tenths (2.5) pounds per square inch (eighteen one-hundredths (0.18) kg. per square cm.).

The adhesive shall form a durable bond to smooth, corrosion and weather-resistant surfaces. The reflective sheeting, applied to cleaned and etched aluminum test panels shall adhere securely, forty-eight (48) hours after application, at temperatures of minus thirty (30) degrees to two hundred (200) degrees Fahrenheit (minus thirty-five (35) degrees Centigrade to ninety-three (93) degrees Centigrade). The adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and prevent its shocking off when jabbed with a spatula at minus ten (10) degrees Fahrenheit (minus twenty-three (23) degrees Centigrade). The sheeting shall resist peeling from the application surface when a five (5) lb./in. width (two and twenty-seven one-hundredths (2.27) kg. per two and fifty-four one-hundredths (2.54) cm. width) force is applied as outlined in ASTM Designation D903.

(f) Film. The reflective sheeting shall have sufficient strength and flexibility so that it can be handled, processed, and applied according to the recommendations of the sheeting manufacturer without appreciable stretching, tearing, or other damage. It shall permit application over and conformance to moderate, shallow embossing characteristics of certain sign borders and symbols. Following liner removal, the reflective sheeting shall not shrink more than one thirty-second (1/32) (seventy-nine one-hundredths (0.79) mm.) in ten (10) minutes nor more than one-eighth (1/8) (three and eighteen one-hundredths (3.18) mm.) in twenty-four (24) hours in any dimension per nine (9) inch (twenty-two and nine-tenths (22.9) cm.) square at seventy-two (72) degrees Fahrenheit (twenty-three (23) degrees Centigrade) and fifty (50) percent RH.

The sheeting when applied according to manufacturer's recommendations to cleaned and etched two one-hundredths (0.02) in. by two (2) in. by eight (8) in. (five and eight one-hundredths (5.08) mm. by five (5) cm. by twenty and three-tenths (20.3) cm.) aluminum, conditioned twenty-four (24) hours and tested at seventy-two (72) degrees Fahrenheit and fifty (50) percent RH shall be sufficiently flexible to show no cracking when bent around a three-fourths (3/4) inch (nineteen and five one-hundredths (19.05) mm.) mandrel.

(g) Surface. The sheeting surface shall be smooth and flat, facilitate cleaning and wet performance, and exhibit eighty-five (85) degrees glossmeter rating of not less than forty (40) (ASTM Designation D523). The sheeting

surface shall be readily processed and compatible with recommended transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and applications.

The sheeting shall permit cutting and color processing at temperatures of sixty (60) to one hundred (100) degrees Fahrenheit (fifteen (15) to thirty-eight (38) degrees Centigrade) and relative humidities of twenty (20) to eighty (80) percent. The sheeting shall be heat-resistant and permit force curing without staining of unapplied sheeting at temperatures up to one hundred fifty (150) degrees Fahrenheit (sixty-five (65) degrees Centigrade) and up to two hundred (200) degrees Fahrenheit (ninety-three (93) degrees Centigrade) on applied sheeting. The sheeting surface shall be solvent resistant such that it may be cleaned with gasoline, WM&P naphtha, mineral spirits, turpentine, methanol, and xylol.

(h) Durability. Reflective sheetings, processed, applied to approved sign base materials, and cleaned, in accordance with manufacturer's recommendations for their use on traffic control signs shall be capable of performing satisfactorily for the number of years stated in Table I if the sheetings have not deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a vehicle, or (2) the average nighttime reflective brightness is less than that specified in Table I.

TABLE I—(Type I)

Sheeting Color	Average min. candlepower per foot candle per sq. ft. at 0.2° divergence and —4° incidence	Satisfactory Performance Life
Silver-White No. 1	30	7 years
Silver-White No. 2	36	7 years
Yellow	20	7 years
Red	5	7 years
Blue	2	7 years
Green	3	7 years
Orange	10	3 years

Type III Reflective Sheeting

(a) Photometric Requirements. The reflective sheeting shall have the following minimum brightness values at two-tenths (0.2) degrees, five-tenths (0.5) degrees, and one and five-tenths (1.5) degrees divergence expressed as average candlepower per foot-candle per square foot (candelas per lux per square meter) of material. Measurements shall be conducted in accordance with standard photometric testing procedures for reflex-reflectors, paragraph 4.4.7 of Federal Specification LS-300A, "Sheeting and Tape, Reflective; Nonexposed Lens Adhesive Backing," or as amended.

Div. Ang. Inc. Ang.	Silver-White			Yellow			Red		
	.2°	.5°	1.5°	.2°	.5°	1.5°	.2°	.5°	1.5°
—4°	250.0	95.0	4.0	150.0	57.0	3.0	35.0	13.0	0.7
40°	120.0	54.0	2.0	70.0	30.0	1.5	17.0	7.5	0.3
	Green			Orange					
	.2°	.5°	1.5°	.2°	.5°	1.5°			
	30.0	11.0	0.4	60.0	20.0	1.0			
	4.0	2.0	0.1	25.0	13.0	0.7			

(b) Wet Performance. Wet performance measurements shall be conducted in accordance with standard rainfall test specified in Federal Specification L–S–300A and the brightness of the reflective sheeting, totally wet by rain, shall not be less than ninety (90) percent of the above values.

(c) Color. The diffuse day color of Type III reflective sheeting shall conform to the following:

TYPE III—CIE Chromaticity Coordinate Limits

Color	x	y	x	y	x	y	x	y	(Y) Reflectance Limit		Ref. Std. Munsell Papers
									Min.	Max.	
Silver-White	.302	.289	.286	.306	.324	.344	.342	.327	30.0	-------	5PB7/0.7
Green	.152	.523	.211	.395	.172	.372	.105	.503	3.0	8.0	9.0G3.3/9.5
Yellow	.483	.352	.510	.490	.560	.440	.534	.414	16.0	32.0	1.25Y6/12
Red	.608	.288	.700	.298	.644	.352	.608	.352	4.0	8.0	8R3.2/13
Orange	.535	.375	.535	.399	.582	.417	.607	.393	19.8	30.0	2.5YR5.5/14.0

(d) Lens Elements. The reflective sheeting shall possess stable and durable spherical lens elements which, following extraction, shall show no deterioration following submersion in a 5N solution of sulphuric acid (H_2SO_4) for thirty (30) minutes at seventy-two (72) degrees Fahrenheit (twenty-three (23) degrees Centigrade).

(e) Adhesive. The reflective sheeting shall include a precoated pressure sensitive adhesive or a tack free heat activated adhesive either of which shall be applied exactly as specified by the sheeting manufacturer to recommended, properly prepared flat surfaces without necessity of additional adhesive coats on the reflective or application surface.

The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solvents and shall be easily removed after accelerated storage for four (4) hours at one hundred fifty (150) degrees Fahrenheit (sixty-five (65) degrees Centigrade) under weight of twenty-five one-hundredths (0.25) pounds per square inch (eighteen one-hundredths (0.18) kg. per square cm.).

The adhesive shall form a durable bond to smooth, corrosion and weather resistant surfaces. The reflective sheeting, applied to cleaned and etched aluminum test panels shall adhere securely, forty-eight (48) hours after application, at all normal application temperatures up to one hundred fifty (150) degrees Fahrenheit (ninety-three (93) degrees Centigrade) after the panels are conditioned for twenty-four (24) hours at minus ten (10) degrees Fahrenheit (minus thirty-five (35) degrees Centigrade), the adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and show no cracking when the surface of the reflective sheeting is exposed to the impact of a two (2) pound (nine-tenths (0.9) kg.) weight with a five-eighths (5/8) inch (fifteen and nine-tenths (15.9) mm.) rounded tip dropped from a ten (10) inch pound (eleven and four-tenths (11.4) cm. kg.) setting on a Gardner Variable Impact Tester, IG–1120M. The sheeting shall resist peeling from the application surface when a five (5) lb./in. width (two and twenty-seven one-hundredths (2.27) kg. per two and fifty-four one-hundredths (2.54) cm. width) force is applied as outlined in ASTM Designation D903.

(f) Film. The reflective sheeting shall have sufficient strength and flexibility so that it can be handled, processed, and applied according to the recommendations of the sheeting manufacturer without appreciable damage. Following liner removal, the reflective sheeting shall not shrink more than one sixty-fourth (1/64) inch (four-tenths (0.4) mm.) in twenty-four (24) hours in any dimension per nine (9) inch (twenty-two and nine-tenths (22.9) cm.) square at seventy-two (72) degrees Fahrenheit (twenty-three (23) degrees Centigrade) and fifty (50) percent RH.

The sheeting with liner removed, conditioned for twenty-four (24) hours at seventy-two (72) degrees Fahrenheit and fifty (50) percent RH shall be sufficiently flexible to show no cracking when bent around a one-eighth (1/8) inch (three and eighteen one-hundredths (3.18) mm.) mandrel with adhesive side contacting mandrel. Note: For ease of testing, spread talcum powder on adhesive to prevent sticking to mandrel.

(g) Surface. The sheeting surface shall be smooth and facilitate cleaning and wet performance, and exhibit eighty-five (85) degrees gloss meter rating of not less than fifty (50) (ASTM Designation D523). The surface of the

sheeting with the heat activated adhesive shall be readily processed in accordance with recommendations of the sheeting manufacturer, compatible with recommended transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and application.

The sheeting shall permit cutting and color processing at temperatures of sixty (60) degrees, minus one hundred (100) degrees Fahrenheit (fifteen (15) degrees, minus thirty-nine (39) degrees Centigrade) and relative humidities of twenty (20) to eighty (80) percent. The sheeting surface shall permit cleaning by wiping with a clean soft rag dampened in V.M.&P. naphtha or mineral spirits.

(h) Impact Resistance. The sheeting, applied according to manufacturer's recommendations to cleaned etched four-tenths (0.4) in. by three (3) in. by five (5) in. (one (1) mm. by seven and six-tenths (7.6) cm. by twelve and seven-tenths (12.7) cm.) aluminum (6061–T6) and conditioned for twenty-four (24) hours at seventy-two (72) degrees Fahrenheit (twenty-three (23) degrees Centigrade) and fifty (50) percent humidity shall show no cracking when face of panel is subjected to impact of a two (2) pound (nine-tenths (0.9) kg.) weight with five-eighths (5/8) inch (fifteen and nine-tenths (15.9) mm.) rounded tip at ten (10) inch pound (eleven and four-tenths (11.4) cm. kg.) setting on a Gardner Variable Impact Tester (IG–1120).

(i) Durability. Reflective sheetings, processed, applied to approved sign base materials, and cleaned, in accordance with manufacturer's recommendations for their use on traffic control signs, shall be capable of performing satisfactorily for the number of years stated in Table II if the sheetings have not deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a vehicle, or (2) the average nighttime reflective brightness is less than that specified in Table II.

TABLE II—(Type III)

Sheeting Color	Average min. candlepower per foot candle per sq. ft. at 0.2° divergence and —4° incidence	Satisfactory Performance Life
Silver-White	200	10
Green	24	10
Yellow	120	10
Red	28	5
Orange	48	3

716.03.02 Blank.

716.03.03 Aluminum Sign Panels. Sheet aluminum for sign panels shall be of one hundred twenty-five one-thousandths (0.125) inch aluminum alloy alclad 5052–H38 or 6061–T6 and shall conform to specifications for ASTM Designation B209.

Sign panel sections shall be fabricated of standard width aluminum sheets not less than four (4) feet wide, except that not more than two (2) sheets for any one (1) sign may be cut not less than eighteen (18) inches in width, so as to provide sign widths to nearest six (6) inch increments. Panel sections shall run from the top edge to the bottom edge of the sign without horizontal joints.

The aluminum shall be free of all corrosion, white rust, and dirt. All sign

dimensions, metal gage, and bolt holes shall conform to the requirements set forth on the plans and in these specifications. Metal degreasing will be required on all sheet aluminum and shall be performed by one (1) of the following methods:

(a) Vapor degreasing. Signs shall be completely immersed in a saturated vapor of trichlorethylene or perchlorethylene. Trademark printing shall be removed with lacquer thinner or a controlled alkaline cleaning system, and rinsed thoroughly with running water.

(b) Alkaline degreasing. Signs shall be completely immersed in a tank containing alkaline solutions controlled and titrated to the solution manufacturer's specification. Immersion time shall depend upon the amount of soil to be removed. Signs shall then be thoroughly rinsed with running water.

Whenever reflective sheeting is required on the sign, the aluminum shall be etched by one (1) of the following methods:

1. Acid etch. The aluminum shall be well-etched in a six (6) to eight (8) percent phosphoric acid solution at one hundred (100) degrees Fahrenheit and rinsed thoroughly with running cold water, followed with a hot water tank rinse.

2. Alkaline etch. Etch well the precleaned aluminum in an alkaline etching material that is controlled by titration. Time, temperature, and concentration shall be specified by the solution manufacturer. Smut shall be removed with an acidic, chromium compound type solution as specified by the solution manufacturer and the sign then rinsed thoroughly.

3. The surface etch shall provide a clean, mat, nonshine or nonglare finish suitable for the application of paint or sheeting and for the unpainted back or reverse side of highway signs.

After the degreasing and etching process, the aluminum shall be dried by use of a forced air drier.

Metal shall not be handled, except by device or clean canvas gloves between all cleaning operations and the application of the sign background material. There shall be no opportunity for the aluminum to come in contact with greases, oils, or other contaminants prior to the application of the background material.

Fabrication of all metal parts shall be accomplished in a uniform and workman-like manner. All fabrication, including cutting, shall be completed prior to the cleaning process. Metal panels shall be cut to size and shape and shall be free of buckles, warp, dents, cockles, burrs, and other defects resulting from fabrication. The surface of all sign panels shall be a plane surface.

716.03.04 Blank.

716.03.05 Overhead Sign Structures and Sign Frames. The materials used in the fabrication of overhead sign structures and footings shall conform to the following requirements:

(a) Sign frames. Bars, plates, and shapes shall be structural steel conforming to the specifications of ASTM Designation A36.

(b) Sign pipe posts. Pipe posts shall be welded or seamless steel pipe conforming to the specifications of ASTM Designation A53, Grade B. At the

option of the Contractor, posts may be fabricated from structural steel conforming to the specifications of ASTM Designation A36 or of ASTM Designation A283, Grade D, except that plates more than one (1) inch in thickness shall be structural steel conforming to the specifications of ASTM Designation A373.

(c) Sign steel walkway gratings. Steel walkway gratings shall be furnished and installed in accordance with details shown on the plans and the following provisions:

1. Gratings shall be the standard product of an established grating manufacturer.

2. Material for gratings shall be structural steel conforming to the specifications of ASTM Designation A36.

3. For welded type gratings, each joint shall be full resistance welded under pressure to provide a sound, completely beaded joint.

4. For mechanically locked gratings, the method of fabrication and interlocking of the members shall be approved by the Engineer, and the fabricated grating shall be equal in strength to the welded type.

5. After fabrication, gratings shall be hot-dip galvanized.

6. Gratings shall be accurately fabricated and free from warps, twists, or other defects affecting their appearance or serviceability. Ends of all rectangular panels shall be square. The tops of the bearing bars and cross members shall be in the same plane. Gratings distorted by the galvanizing process shall be straightened.

(d) Bolts, Nuts, and Washers. High-strength steel bolts, nuts, and washers shall conform to the specifications of ASTM Designation A325. All other bolts and nuts, including anchor bolts and nuts for sign foundations, shall conform to the specifications of ASTM Designation A307, and shall be furnished with commercial quality washers. Bolted connections shall conform to the provisions in subsection 506.03.10, "Bolts and Bolted Connections."

(e) Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation A36. Galvanizing shall conform to ASTM Designation A123. All welding shall conform to the requirements set forth in subsection 506.03.20, "Welding."

(f) Anchor bolts, nuts, and washers shall be of structural carbon steel conforming to Section 710, "Structural Steel," and shall be galvanized in accordance with ASTM Designation A153, or cadmium plated in accordance with ASTM Designation A165, Type TS. The top portion of anchor bolts shall be galvanized or cadmium plated to such extent that the galvanized or cadmium plated portion will extend at least two (2) inches into concrete. Anchor bolts shall be of the size, shape, and length as shown on the plans.

(g) All bolts, nuts, clamps, and metal washers not otherwise noted shall be galvanized or cadmium plated. Cadmium plating shall conform to the specifications of ASTM Designation A165, minimum thickness as prescribed for grade Type TS, and galvanizing shall conform to the requirements of ASTM Designation A153.

(h) Steel sign panels shall be mounted using one-fourth (1/4) inch by twenty (20) inch flat head, brass machine screws with a No. 14 brass, nickel plated, asbestos backed, finishing washer and one (1) brass nut with a flat brass

washer and lock washer for each machine screw. Lock washers shall be plain phosphor bronze or beryllium copper, shake-proof, and externally toothed. Where obstructions prevent the normal installation of nuts, the frame shall be drilled and tapped to accept the screw. The exposed portion of fastening hardware on the face of the sign panels shall be painted out using commercial quality touch-up enamel that matches the background.

The following type fasteners may be used in lieu of those specified above:

Either a silicone bronze or an aluminum alloy 5052 or 5056, self-plugging blind rivet with a nominal diameter of nine thirty-seconds (9/32) inch. The rivet head shall be not less than seven-tenths (0.7) inch nor more than eight-tenths (0.8) inch in diameter and shall be undercut to make deburring of the mounting hole unnecessary. The rivet shall develop a clamping force of not less than three hundred fifty (350) pounds.

(i) Supporting frame shall be manufactured in accordance with the plans and in accordance with the requirements herein specified. All metal parts shall be galvanized after fabrication, in accordance with the provisions of Section 715. When permission is granted by the Engineer to zinc coat a surface by means other than hot-dip galvanizing, the metalizing process shall be used to place the zinc. Metalizing shall be performed in accordance with the AWS Specifications and the thickness of the sprayed zinc coat shall be at least five (5) mils.

(j) Truss frames shall be fabricated to the largest practical sections prior to galvanizing. Splice locations shall be submitted to the Engineer for approval and the Contractor shall not commence fabrication until such splice locations are approved.

(k) All welding in the fabrication of the structure shall be done in accordance with the requirements of subsection 506.03.20, "Welding." No field welding on any part of the structural assembly will be permitted.

Note: Before fabrication is started, five (5) sets of shop drawings for each overhead sign structure shall be submitted to the Engineer for approval.

716.03.06 Sign Hardware and Related Materials. Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation A36. Galvanizing shall conform to ASTM Designation A123. All welding shall conform to the requirements set forth in subsection 506.03.20, "Welding."

All bolts, nuts, clamps, and metal washers shall be of structural, carbon steel conforming to Section 710 and may be galvanized or cadmium plated as hereinafter stated.

Anchor bolts, nuts, and washers shall be of structural carbon steel conforming to Section 710, "Structural Steel," and shall be galvanized in accordance with ASTM Designation A153, or cadmium plated in accordance with ASTM Designation A165, Type TS. The top portion of anchor bolts shall be galvanized or cadmium plated to such extent that the galvanized or cadmium plated portion will extend at least two (2) inches into concrete. Anchor bolts shall be of the size, shape, and length as shown on the plans.

Aluminum alloy tubular stiffeners shall be schedule 40 pipe fabricated of

6061–T6 aluminum alloy and shall conform to the specifications of ASTM Designation B241.

Steel pipe for posts shall conform to the specifications of ASTM Designation A120 and shall be galvanized.

Galvanized steel pipe posts shall be of the diameter and length shown on the plans. The top of the posts shall be fitted with a cover. Posts showing damage shall be repaired or rejected.

The straps, bars, and braces used on single support signs shall be of aluminum alloy 6061–T6 and shall conform to ASTM Designation B209.

Stringers for horizontal supporting structural members shall be of 6061–T6 or 6062–T6 aluminum alloy and shall conform to ASTM Designation B308, Alloy GS11A.

All bolts, nuts, clamps, and metal washers in contact with aluminum shall be cadmium plated. All other bolts, nuts, clamps, and metal washers shall be galvanized or cadmium plated. Cadmium plating shall conform to the specifications of ASTM Designation A165, minimum thickness as prescribed for grade Type TS and galvanizing shall conform to the requirements of ASTM Designation A153.

Wood posts and braces for sign supports shall be constructed of Douglas Fir, West Coast Hemlock, or any other equivalent stress rated wood material, at the option of the Contractor. Said wood material shall be construction grade, free of heart center, minimum stress rating of 1200f, and shall be graded in accordance with the provisions contained in Section 718. Sweep shall not exceed eight one-hundredths (0.08) feet in ten (10) feet.

The expansion assembly for fastening the aluminum tubing to the aluminum Z-bars shall be manufactured of a zinc die casting alloy which contains copper, aluminum, and magnesium. The anchor bolt for the expansion assembly shall be cadmium plated and shall conform to the specifications of ASTM Designation A165, minimum thickness as prescribed for grade Type TS.

Square sign posts and anchors shall conform to the following requirements:

Material. Steel posts shall conform to ASTM Designation A446 or A569. Steel posts shall have a minimum yield of forty thousand (40,000) p.s.i. after fabrication with certification being required.

Shape. The cross section of post shall be a square tube formed of ten (10) gauge (one hundred thirty-five one-thousandths (0.135) inch U.S.S. gauge) or twelve (12) gauge (one hundred five one-thousandths (0.105) inch U.S.S. gauge) steel carefully rolled to size and welded. The cross section of the sign post anchor and sleeve used with the two (2) inch post will be same as for the sign posts. The cross section of the sign post anchor used with the two and one-half ($2\frac{1}{2}$) inch post shall be a square tube formed of three-sixteenths ($\frac{3}{16}$) inch steel carefully rolled to size and welded.

Fabrication. The furnished members shall be straight and shall have a smooth uniform finish. All holes and cut off ends shall be free from burrs.

Finish. All posts shall be weather protected. Posts made from material conforming to ASTM A446 shall be formed from steel which has been zinc coated in accordance with ASTM A525, Designation G–90.

Posts made from material conforming to ASTM A569 shall be coated in accordance with the applicable provisions of AASHTO M181 for Class 2 posts, except as hereinafter modified.

AASHTO M181 is hereby modified as follows:

(a) Article 8.2.2.2. The weight of zinc coating on the exterior surface of posts shall be a minimum of forty-five one-hundredths (0.45) ounce per square foot as determined from the average results of two (2) or more specimens and not less than forty one-hundredths (0.40) ounce per square foot on an individual sample.

(b) Article 8.2.2.4. The weight of chromate conversion coating on posts shall be a minimum of five (5) micrograms per square inch.

Size. Sizes shall conform to those shown on the plans or as approved when used as an alternate.

Channel sign posts and base posts shall conform to the following requirements:

Material. Posts shall be rolled from high strength hot rolled steel conforming to ASTM Designation A499 modified to sixty thousand (60,000) p.s.i. minimum yield and ninety thousand (90,000) p.s.i. minimum tensile or equal.

Shape. Posts shall be of a uniform channel shape. The dimensions of these posts shall be as noted on Standard Plan Sheet T–31.1.8 and special detail sheets in the contract plans.

Weight. The weight of each base post and each sign post before holes are punched shall be two and seventy-five one-hundredths (2.75) and four (4) pounds per foot for base posts and two and five-tenths (2.5) and four (4) pounds per foot for sign posts. The two and seventy-five one-hundredths (2.75) pound base post shall be used with two and five-tenths (2.5) pound sign post and the four (4) pound base post with the four (4) pound sign post.

Fabrication. The furnished members shall be straight and have a smooth uniform finish. All holes and cut off ends shall be free of burrs.

Finish. All posts shall be weather protected by galvanizing. This galvanizing shall conform to ASTM Designation A123.

Size. Sizes shall conform to those shown on plans or as approved when used as an alternate.

The pipe, wyes, tees, and elbows used to construct Rent Construction Barricades (Type III B) shall be made of polyvinyl chloride (PVC) plastic pipe. The PVC pipe shall conform to the requirements of ASTM Designation D2241 for PVC 1120 or 1220, SDR 21, pressure rating two hundred (200) p.s.i. The PVC wyes, tees, and elbows shall conform to the requirements of ASTM Designation D2466, Type II, Grade 1. At the Contractor's option, pipe, wyes, tees, and elbows may be acrylonitrile-butadiene-styrene (ABS) conforming to the requirements of ASTM Designation D2751. Combinations of PVC and ABS pipe and fittings will be permitted. All joints shall be slip-fit and shall not be threaded or cemented.

SECTION 717

TIMBER PILES

SCOPE

717.01.01 Materials Covered. This specification covers the quality of round timber piles.

REQUIREMENTS

717.02.01 Certificates. Inspection certificates shall be furnished without extra charge with each shipment of timber piles. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

Timber piles to be treated shall be inspected prior to treatment by an inspector designated by the Engineer. The inspector shall stamp each pile on the butt end with a stamp which shall make an impression that is readily legible after treatment. The stamp shall be copyrighted and a true impression filed with the Department of Highways.

PHYSICAL PROPERTIES AND TEST

717.03.01 General. Timber piles shall conform to the requirement of ASTM Designation D25.

SECTION 718

TIMBER

SCOPE

718.01.01 Materials Covered. This specification covers the quality requirements for structural timber, lumber, guardrail posts, markers, and miscellaneous items.

REQUIREMENTS

718.02.01 Grades. Grades furnished shall be as noted on the plans or in the special provisions.

718.02.02 Certificates of Inspection. Inspection certificates shall be furnished without extra charge with each shipment of timber. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

PHYSICAL PROPERTIES AND TESTS

718.03.01 Species. The standard commercial and botanical names recognized by these specifications are described as follows:

Standard Commercial Name	Botanical Name
Cedar, Port Orford	Chamaecyparis lawsoniana
Fir, Douglas (coast)	Pseudotsuga menziesii (coast type)
Fir, Douglas (inland)	Pseudotsuga menziesii (inter-mountain type)
Hemlock, West Coast	Tsuga heterophylla
Larch	Larix occidentalis
Redwood, California	Sequoia sempervirens

718.03.02 Grades. Structural timber and lumber shall meet the requirements for the numerical stress shown on the plans, or as may be otherwise specified, when graded by rules developed in accordance with AASHTO M168. Any commercial grading rules that will provide material of an equal or greater stress value may be used.

The West Coast Lumber Inspection Bureau and the Western Wood Products Association grading rules shall be included as grading rules which may be used. Grading rules in effect on the date of advertisement of bids shall govern.

Guardrail posts and blocks shall meet the following requirements:

Douglas Fir or Western Larch shall conform to the requirements for "No. 1 Structural," grade as set forth in paragraph 131-b of the grading rules of the West Coat Lumber Inspection Bureau or paragraph 80.11 of the grading rules of the Western Wood Products Association.

West Coast Hemlock shall conform to the requirements for "Select Structural," grade as set forth in paragraph 131-a of the grading rules of the West Coast Lumber Inspection Bureau or paragraph 80.10 of the grading rules of Western Wood Products Association.

SECTION 719

TIMBER PRESERVATIVES

SCOPE

719.01.01 Materials Covered. This specification covers the type and quality of materials used in the preservative treatment of timber.

PHYSICAL PROPERTIES AND TESTS

719.03.01 Preservatives. Timber preservatives shall conform to the requirements of AASHTO M133.

SECTION 720

GUARDRAIL MATERIALS

SCOPE

720.01.01 Materials Covered. This specification covers the quality and kind of material used in the construction of guardrail.

REQUIREMENTS

720.02.01 Certificates. Two (2) certified copies of mill test reports showing the chemical and physical characteristics from each heat from which metal is used shall be furnished by the Contractor.

Certificates for wood posts shall be furnished in accordance with subsection 718.02.02, "Certificates of Inspection."

Rail members, bolts, nuts, and other fittings shall be interchangeable with similar parts regardless of source.

PHYSICAL PROPERTIES AND TESTS

720.03.01 Rail Members. The beam-type members, comprising rail members and end or terminal pieces, shall be formed from (1) open-hearth, basic oxygen, or electric-furnace steel sheets, galvanized after fabrication, or (2) aluminum alloy sheets as the Contractor may elect. The thickness of steel sheets before galvanizing, and the thickness of aluminum sheets shall be not less than one-tenth (0.1) inch (nominal twelve (12) gage and allowing for tolerances). The metal in the members shall meet the minimum requirements of the following table as determined by testing in accordance with ASTM Designation A525:

Strength Requirements for Beam-Type Rail Members

	Rail	End Piece
Ultimate Tensile Strength	67,000 p.s.i.	--------
Yield Point Strength	--------	25,000 p.s.i.
Elongation in Two-Inch Gage Length	12 percent	--------
Total Ultimate Strength at Splices	80,000 lbs.	80,000 lbs.

Steel members shall be galvanized in accordance with Section 715, "Galvanizing."

720.03.02 Fittings. All bolts, nuts, washers, and other fittings for beam-type guardrail shall be steel and of a quality adequate to develop the specified strength of rail splices and to provide a post connection withstanding a five thousand (5,000) pound side pull in either direction.

All bolts, nuts, and washers shall be five-eighths (5/8) inch size. Bolts shall be buttonhead style and nuts shall be hexagonal. Bolts and nuts shall be coarse-threaded (eleven (11) per inch), with nuts tapped oversize not to exceed one thirty-second (1/32) inch. Outside dimensions of boltheads, nuts, and washers shall have the following minimums: boltheads one and one-

fourth (1 1/4) inches; nuts, fifteen-sixteenths (15/16) inch; and washers, one and one-half (1 1/2) inches. Splice bolts shall be one and one-fourth (1 1/4) inches in length, and post connection bolts shall be of lengths required to fit the post dimension and extend beyond the tightened nuts thereon within limits of one-fourth (1/4) to one-half (1/2) inch. Washers, one-eighth (1/8) inch thick, shall be provided for use under nuts on all post bolts, and under any nut which has a width of less than one and one-sixteenth (1 1/16) inches.

All fittings shall be galvanized in accordance with Section 715, "Galvanizing."

720.03.03 Reflector Plates. Reflector plates shall be fabricated from eleven (11) gage steel sheet or one hundred forty-eight one-thousandths (0.148) inch thick aluminum sheet alloy 6061–T6. Nails for fastening reflector plates to the guardrail post shall be either galvanized metal or aluminum. Steel reflector plates shall be galvanized. Reflectorized material for reflector plates shall conform to the requirements of subsection 721.03.03, "Reflectors."

SECTION 721

OBJECT MARKERS AND GUIDE POSTS

SCOPE

721.01.01 Materials Covered. This specification covers the quality and kind of materials used in the construction of object markers and guide posts.

REQUIREMENTS

721.02.01 Certificates. Without expense to the Department, two (2) certificates covering each order of material (plates, reflectors, and posts) shall be furnished by the manufacturer, certifying that the product complies with the specifications. Certificates shall be delivered to the Engineer in charge at the jobsite at the time of, or prior to, delivery of the order.

PHYSICAL PROPERTIES AND TESTS

721.03.01 Metal Posts. Posts shall be steel conforming to ASTM Designation A570, Grade C, or ASTM Designation A526, twelve (12) or thirteen (13) gage.

Metal posts shall be galvanized in accordance with Section 715, "Galvanizing," or in accordance with the requirements of ASTM Designation A525, coating designation G210.

721.03.02 Target Plates (a) Base Metal. Base metal for target plates shall be zinc-coated steel sheet or aluminum sheet.

The zinc-coated steel sheet shall comply with Federal Specification QQ–S–775 Steel Sheet, carbon, zinc-coated Type 1, Classes d and e, except that the zinc-coated surface shall withstand a one hundred eighty (180) degree bend on itself at room temperature without flaking the coating. The zinc-coated surface shall be prepared for painting by the application of phosphate coating. Surface preparation shall conform to the following requirements: The phosphatizing process shall be accomplished without damaging or removing the galvanized coating from the steel base metal. Any evidence of damage or removal of the zinc coating shall be cause for rejection of the entire lot.

The aluminum sheet shall be prepared for painting with a chemical conversion coating conforming to the requirements of Federal Specification MIL–C–5541. The coating shall be applied in accordance with the manufacturer's specifications and recommended sequence of operation. Two (2) copies of certified mill tests of the aluminum sheets shall be furnished to the Engineer.

Target plates shall be fabricated from twenty (20) gage steel sheet or five one-hundredths (0.05) inch thick aluminum sheet, alloy 3005–H14.

Fabrication of all metal parts shall be accomplished in a uniform and workmanlike manner. Plates shall be cut to size and shape and the holes punched for mounting bolts and reflectors in accordance with the details shown on the plans. Surfaces and edges of the plates shall be free from defects resulting from fabrication.

(b) Paint. Target plates shall have satisfactory paint adherence.

At the Contractor's option, metal reflector plates for metal guide posts may be furnished with one (1) or both sides coated with a black, baked enamel finish. If only one (1) side is coated, the coated side shall face oncoming traffic.

The plates shall be coated with baked enamel conforming to the following provisions:

The enamel finish coat for plates shall comply in all respects with the requirements of Federal Specification TT–E–489, Class B baking type enamel, with the added requirement that the yellowness index of the white enamel shall not exceed eight one-hundredths (0.08) when tested in accordance with Federal Test Method Standard No. 141, Method 6131.

Application of the baking enamel may be by spray, roller, or dip, at the option of the manufacturer. Other methods may be used provided they are approved prior to use. The dry film thickness of the baked enamel coating on the galvanized steel plates shall be not less than two (2) mils on both front and back surfaces. The dry film thickness on both front and back surfaces of the aluminum plates shall be not less than one and five-tenths (1.5) mils on each side if enamel is applied by spray or dip method and not less than one (1) mil if enamel is applied by continuous roller coat method.

The coating shall be uniform throughout and shall be smooth and free from flow lines, streaks, blisters, or other surface imperfections.

The finished plates shall be free from dents and defects. The maximum surface deviation from a horizontal plane on which the finished plate lies shall not exceed twenty-five one-hundredths (0.25) inch.

721.03.03 Reflectors. Metal guide posts shall be equipped with reflective sheeting conforming to the requirements of subsection 716.03.01 of these specifications for Type I.

The size of the sheeting shall be as indicated on the plans. The color of the sheeting shall be as indicated in the MUTCD Manual.

SECTION 722

WATER

SCOPE

722.01.01 Material Covered. This specification covers the quality of water for use in preparing cement concrete or soil-cement mixtures, and for wetting embankment, backfill, subgrade, and gravel base and surfacing courses.

REQUIREMENTS

722.02.01 General. All water for embankments, backfill, subgrade, gravel base, landscaping, and surface courses and cement concrete curing shall be free from an excessive amount of acids, alkali, oil, and other substances which, in the opinion of the Engineer, will cause damage to the above-mentioned items.

PHYSICAL PROPERTIES AND TESTS

722.03.01 Concrete Use. Samples submitted for tests shall each consist of two (2) quarts of water, obtained and shipped in clean containers carefully packed and labeled. Tests shall be made in accordance with AASHTO Designation T26, standard method of test for quality of water to be used in concrete.

Water with a pH less than four and five-tenths (4.5) or greater than eight and five-tenths (8.5) and a resistivity less than five hundred (500) ohm/cm. shall be tested in accordance with AASHTO Designation T26, paragraph 3.4.

Any indication of unsoundness, marked change in time of setting, or a reduction of more than ten (10) percent in strength from results obtained with concrete mixtures containing the water of satisfactory quality shall be sufficient cause for rejection of the water under tests.

SECTION 723

HARDWARE

SCOPE

723.01.01 Materials Covered. This specification covers the quality of bolts, nuts, washers, drift pins, dowels, nails, spikes, and other metal fastenings.

PHYSICAL PROPERTIES AND TESTS

723.03.01 Galvanizing. Galvanizing, when required, shall meet the current Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware, ASTM Designation A153.

723.03.02 Bolts, Nuts, Dowels, and Drift Bolts. Bolts, nuts, dowels, and drift bolts shall conform to the requirements of the current Specification for Steel Machine Bolts and Nuts and Tap Bolts, ASTM Designation A307, Grade A, unless otherwise specified.

723.03.03 Washers. Cast washers shall be of cast iron of the O-gee type. The diameter shall be not less than three and one-half ($3\frac{1}{2}$) times the diameter of the bolts for which it is used. The diameter of the hole shall be one-eighth ($\frac{1}{8}$) inch larger than the diameter of the bolt.

Flat malleable washers shall be of malleable iron with ribs properly proportioned to develop the full strength of the bolt and, unless otherwise shown on the plans, the diameter shall be not less than three and one-half ($3\frac{1}{2}$) times the diameter of the bolt for which it is used and its thickness equal to one-half ($\frac{1}{2}$) the diameter of the bolt. The diameter of the hole shall be one-eighth ($\frac{1}{8}$) inch larger than the diameter of the bolt.

SECTION 724

FENCE MATERIALS

SCOPE

724.01.01 Materials Covered. This specification covers the quality of barbed wire, woven wire, and chain-link fabric fencing, fence posts, gates, and miscellaneous fence hardware.

REQUIREMENTS

724.02.01 Samples and Certificates of Inspection. Without expense to the Department, two (2) certificates covering each order of material shall be furnished by the manufacturer, certifying that the various metal components comply with the requirements herein. The certificates shall be delivered to the Resident Engineer at the time of, or prior to, delivery of the order.

PHYSICAL PROPERTIES AND TESTS

724.03.01 Wood Posts. Intermediate braced posts and braces shall be of the same type as line posts.

End, gate, and corner post assemblies, including bracing timber, shall be sawed and shall conform to the grading requirements of Section 718, "Timber." They shall be of Douglas Fir, Larch, or Southern Pine.

Line posts and intermediate braced posts and bracing shall be round and shall be of Douglas Fir, Southern Pine, Lodge Pole Pine, or Larch manufactured from sound live trees well seasoned and free from large knots, shakes, or splits or other defects which will impair their strength or durability. The posts and braces shall be peeled to remove all outer bark and all inner cambium bark, except an occasional strip of inner bark may remain if not over one-half (1/2) inch wide or three (3) inches long. All knots shall be trimmed flush with the side, spurs and splinters removed, and ends cut square.

For "Type B" and "Type C" fence, line posts and intermediate braced posts and braces shall not be less than seven (7) feet long and all other posts and horizontal braces shall not be less than eight (8) feet long.

For "Type DB" and "Type DC" fence, line posts shall not be less than six (6) feet long, intermediate braced posts and braces shall not be less than six (6) feet six (6) inches long, posts for corner and end post assemblies shall not be less than seven (7) feet six (6) inches long and horizontal braces for corner and end post assemblies shall not be less than eight (8) feet long.

The small end of round line posts and braces shall be between three and one-half (3 1/2) and four and one-half (4 1/2) inches in cross sectional dimension; the small end of intermediate braced posts shall be between five and one-half (5 1/2) and six and one-half (6 1/2) inches in cross sectional dimension. The allowable taper from end to end of round posts and braces shall not exceed one and one-half (1 1/2) inches.

24

All posts and braces shall be pressure treated with creosote, creosote-coal tar solution, or pentachlorophenol solution in accordance with Section 719, "Timber Preservatives," of these specifications.

All posts and braces shall be treated with the same type of preservative.

When pressure treated materials have been damaged or when it has been absolutely necessary to cut or bore into them, after delivery to the jobsite, all exposed untreated wood shall be carefully field treated with preservative applied either by thorough swabbing or by an approved bolt-hole treater as the Contractor may elect.

724.03.02 Metal Posts. Tubular posts shall be galvanized standard-weight steel pipe conforming to the requirements of the current Standard Specification for Black and Hot-Dipped Zinc (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses, ASTM Designation A120, except that the hydrostatic test will not be required.

At the Contractor's option, pipe posts conforming to the requirements of AASHTO Designation M181, Grade 2, may be substituted for the pipe specified in these specifications.

The base metal for the manufacture of other steel sections used for posts and braces shall be good commercial quality weldable steel.

Posts and braces shall conform to the following requirements:

For Chain-Link Fence 72 Inches and Less

Location	Type	Min. Size, Inches	Min. Weight Pounds Per Linear Foot
End, corner, and pull	Pipe	2.375 O.D.	3.65
	Type II	3.5 x 3.5	4.847
Line	Pipe	1.900 O.D.	2.72
	C-Section	1.875 x 1.625	2.28
Braces	Pipe	1.660 O.D.	2.27
	C-Section	1.625 x 1.25	1.35
Gate—Single to 6 ft. or double to 12 ft., incl	Pipe	2.375 O.D.	3.65
Gate—Single over 6 ft. to 13 ft. or double over 12 ft. to 26 ft., incl	Pipe	4.000 O.D.	9.11
Gate—Single over 13 ft. to 18 ft., incl	Pipe	6.625 O.D.	18.97

For Standard Type A, Type C, Type DA, and Type DC Fencing

Location	Type	Min. Size, Inches	Min. Weight Pounds Per Linear Foot
End, corner, pull, and gate	Pipe	2.375 O.D.	3.65
Line	T-Section		1.3
Braces	Pipe	1.660 O.D.	2.27

Gate posts for Standard Type A fencing shall be as set forth in these specifications for chain-link fence except that for single gates over thirteen (13) feet to eighteen (18) feet the posts shall be pipe, four (4) inches O.D. (min.) weighing not less than nine and eleven one-hundredths (9.11) pounds per linear foot.

T-section posts shall be manufactured of steel conforming to the requirements of ASTM Designations A283, A663, or A675, or shall be manufactured to comply with the requirements of ASTM Designation A702, T-section type. T-section posts shall be manufactured to tolerances and workmanship as provided in ASTM Designation A702.

T-section posts shall be provided with tapered anchor plates attached securely thereto. The anchor plates shall weigh not less than sixty-seven one-hundredths (0.67) pound and have a minimum area of fifteen (15) square inches. The top edge of the anchor plate shall be from sixteen (16) to twenty-four (24) inches above the bottom end of the line post for Type A and Type C fence and this dimension shall be sixteen (16) to twenty-two (22) inches for Type DA and Type DC fence. The anchor plate may be omitted provided the post is set in concrete. Each post shall be furnished with galvanized wire clamps as follows: one (1) clamp for each strand of barbed wire; and clamps for the top, bottom, and at not more than fourteen (14) inch intervals between top and bottom for mesh fencing.

T-section posts shall be galvanized or painted with anticorrosive paint. The posts shall be drilled, notched, or studded to facilitate fastening the fencing.

724.03.03 Barbed Wire. Barbed wire may be either steel or aluminum alloy.

Barbed wire shall be composed of two (2) strands of No. 12½ gage (steel wire gage) wire with four (4) point barbs of fourteen (14) gage spaced not more than five (5) inches apart.

Steel barbed wire shall conform to the requirements of ASTM Designation A121 except that the minimum weight of zinc coating shall be two-tenths (0.2) oz. per sq. ft. of uncoated wire surface.

Aluminum alloy barbed wire shall be manufactured of aluminum alloy conforming to ASTM Designation B211, alloy 5052–0 for the line wire and alloy 5052–H38 for the barbs.

724.03.04 Woven Wire. Woven wire shall conform to the requirements of ASTM A116, No. 12½ farm, except that the minimum weight of coating shall be two-tenths (0.2) oz. per sq. ft. of uncoated wire surface.

724.03.05 Chain Link Fabric. Mesh for chain-link fence shall be as follows: chain-link fabric and required fittings and hardware shall conform to the requirements of AASHTO M181, Type I or Type II, except that for Type I the fabric shall be galvanized with the minimum weight of coating of one and two-tenths (1.2) ozs. per sq. ft. of uncoated wire surface. The wire used in the manufacture of the fabric shall be eleven (11) gage for all fence seventy-two (72) inches or less in height, and the mesh size shall be two (2) inches.

Mesh for pedestrian rail shall be as follows: chain-link fabric and required fittings and hardware shall conform to the requirements of AASHTO M181, Type I or Type II, except that for Type I the fabric shall be galvanized with the minimum weight of coating of one and two-tenths (1.2) ozs. per sq. ft. of uncoated wire surface. The wire used in the manufacture of the fabric shall be nine (9) gage, and the mesh size shall be one (1) inch.

724.03.06 Staples, Brace Wire, and Nails. Brace wire shall be eight (8) gage, medium temper, fifty-five thousand (55,000) to seventy-five thousand (75,000) p.s.i. tensile strength and shall be galvanized in accordance with the requirements specified for barbed wire.

Staples shall be made from No. 9 U.S. Steel Wire gage Galvanized and shall be of the L-shaped (strong-hold) type. The long shank shall be threaded one and three-fourths (1¾) inches long.

724.03.07 Metal Gates. (a) Drive Gates for Standard Fencing. The gate frames shall be constructed of not less than one (1) inch galvanized standard weight pipe conforming to the dimensions, nominal weights, and galvanizing specified in the current ASTM Designation A53 (hydrostatic test will not be required). Galvanized tubular steel braces shall be placed vertically in each gate, and corner and brace joints shall be so secured that the gate will retain a true rectangular shape.

The wire mesh shall be rectangular mesh or two (2) inch diamond mesh and shall be galvanized in accordance with the requirements herein specified for woven wire fabric.

(b) Drive Gate for Chain-Link Fencing. The gate frame shall be constructed of not less than one and one-half (1½) inch galvanized standard weight pipe conforming to the dimensions, nominal weights, and galvanizing specified under the current ASTM Designation A53 (hydrostatic test will not be required). Gate frames shall be cross-trimmed with galvanized three-eighths (⅜) inch adjustable truss rods. The corners of the gate frames shall be fastened together and reinforced with malleable iron fittings designed for the purpose of welding.

Chain-link fence fabric as specified for the fence shall be attached to the gate frame by the use of stretcher bars and tie wires as specified for fence construction and suitable tension connectors spaced at approximate one (1) foot intervals.

(c) Walk Gates. Unless otherwise specified, walk gates shall be three and one-half (3½) feet wide and of the height corresponding to the adjacent fence.

The gate frame shall be constructed of not less than three-fourths (¾) inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under the current ASTM Designation A53 (hydrostatic test will not be required).

The gate frame shall be filled with fabric meeting the requirements for fabric as specified herein.

The gate shall be furnished complete with approved hinges, latches, and auxiliary braces as required.

SECTION 725

ELASTOMERIC BEARING PADS

SCOPE

725.01.01 Materials Covered. This specification covers the material in elastomeric bearing pads as herein specified and shall include plain bearings (consisting of elastomer only) and laminated bearings (consisting of layers of elastomer restrained at their interfaces by bonded laminates).

The elastomer portion of the elastomeric compound shall be one hundred (100) percent virgin chloroprene (neoprene) meeting the requirements of Table A. Compounds of nominal hardness between the values shown may be specified and the test requirements interpolated. When test specimens are cut from the finished product a ten (10) percent variation in "Physical Properties" will be allowed.

REQUIREMENTS

725.02.01 Certificate of Inspection. Elastomeric bearing pad material shall be tested by a reputable testing laboratory, recognized by the State, who shall certify that the material meets these specifications and requirements. The certification shall include a certified copy of the test results on samples of the material to be used in the pads. This applies to both the elastomer and laminated material. The Contractor shall furnish the Department with this certification prior to using the material.

PHYSICAL PROPERTIES AND TESTS

725.03.01 General.

TABLE A

ASTM Standard	Physical Properties	50 Duro	60 Duro	70 Duro
D2240	Hardness	50 ± 5	60 ± 5	70 ± 5
D412	Tensile strength, min. p.s.i.	2500	2500	2500
D412	Ultimate elongation, min. percent	400	350	300
	Heat Resistance			
	Change in durometer hardness, max. points	+10	+10	+10
D573—70 hr.	Change in tensile strength, max. percent	—15	—15	—15
@212F. (100C.)	Change in ultimate elongation, max.	—40	—40	—40
	Compressive Set			
D395—Method B	22 hours @158F. max. percent	25	25	25

	Ozone			
D1149	100 pphm ozone in air by volume, 20 percent strain; 104F. ± 3.6F., (40C. ± 2C.) 100 hours; mounting procedure D518, Procedure A	No Cracks	No Cracks	No Cracks
	Adhesion			
D429—Method B	Bond made during vulcanization lbs. per inch	30	30	30
	Low Temperature Test			
D746—Procedure B	Brittleness at —40F. (—40C.)	No Failure	No Failure	No Failure

Laminates shall be:

Rolled mild steel sheets with a nominal thickness of seventy-five one-thousandths (0.075) inch (fourteen (14) gage) conforming to ASTM A366 or A569; or

Fabric reinforcement woven from one hundred (100) percent glass fibers of "E" type yarn with continuous fibers. The minimum thread count in either direction shall be twenty-five (25) threads per inch. The fabric shall have either a crow-foot or an 8 Harness Satin Weave. Each ply of fabric shall have a breaking strength of not less than eight hundred (800) pounds per inch of width in each thread direction when three (3) inch by thirty-six (36) inch samples are tested on split drum grips. The bond between double plies shall have a minimum peel strength of twenty (20) pounds per inch as determined by ASTM D429, Method B.

725.03.02 Manufacturing Requirements. Elastomeric bearings shall be composed of plain bearings consisting of elastomer only or laminated bearings composed of multiple laminates of elastomeric material separated by steel or fabric reinforcing. Plain bearings may be molded individually, cut from previously molded strips or slabs, or extruded and cut to length. Bearings having steel plates as the reinforcement shall be cast as a unit in a mold under pressure and heat and the steel plates separating the elastomeric layers shall be completely bonded by vulcanization to the elastomeric material on all surfaces. Any external load bearing steel plates shall be factory vulcanized to the elastomeric bearings during the primary molding process. Bearings with fabric reinforcement may be cut from large sheets. Cutting shall be performed in such a manner as to avoid heating the materials and to produce a smooth edge with no tears or other jagged areas and to cause as little damage to the materials as possible. The fabric separating the elastomeric layers shall be completely bonded by vulcanization to the elastomer on both sides.

The following details shall also apply:

There shall be a minimum of one-eighth (1/8) inch edge seal, integral with the bearing, over all internal steel plates. No neoprene cover will be required over internal steel plate details which will not be exposed to moisture after erection.

Unless otherwise indicated on the plans, there shall be a constant minimum thickness of one-fourth (1/4) inch elastomeric bedding surface on both the top and bottom of the bearings for bearings with steel reinforcement. This

thickness shall be one-eighth (1/8) inch maximum when fabric reinforcement is used. When an external load plate is required, there shall be an effective neoprene laminate between the load plate and the internal reinforcement.

For fabric reinforced bearings the reinforcement shall be single ply at the top and bottom surfaces of the pad and double ply within the pad. The reinforcement of both the steel or fabric type shall be parallel to the top and bottom surfaces of the pad.

Stacking of individually laminated pads to attain the required thickness will not be permitted; however, cold bonding of individual laminated pads will be permitted providing the bond between the pads has a minimum peel strength of twenty (20) pounds per inch as determined by ASTM D429, Method B.

725.03.03 Tolerances. For both plain and laminated bearings, the permissible variation from the dimensions and configuration required by the plans and these specifications shall be as follows:

(a) Overall Vertical Dimensions—
Average Total Thicknesses 1 1/4 inches or less ..... —0, + 1/8 inch
Average Total Thickness over 1 1/4 inches ..... —0, + 1/4 inch

(b) Overall Horizontal Dimension—
36 inches and less ..... —0, + 1/4 inch
Over 36 inches ..... —0, + 1/2 inch

(c) Thickness of Individual Layers of Elastomer—
(Laminated Bearing Only) ..... ± 1/8 inch

(d) Variation from a Plane Parallel to the Theoretical Surface (as determined by measurements at the edges of the bearings)—
Top ..... 1/8 inch
Sides ..... 1/4 inch
Individual Nonelastic Laminates ..... 1/8 inch

(e) Position—
Position of Exposed Connection Members ..... 1/8 inch

(f) Edge Cover—
Edge Cover of Embedded Laminates or Connection Members ..... —0, + 1/8 inch

(g) Size—
Size of Holes, Slots, or Inserts ..... ± 1/8 inch

(h) Position—
Position of Holes, Slots, or Inserts ..... ± 1/8 inch

725.03.04 Quality Assurance. Whenever practical, the mechanical properties of the finished bearing shall be verified by laboratory test.

The following values shall be met under laboratory testing conditions of full size bearings:

(a) Compressive strain of any layer of an elastomeric bearing shall not exceed seven (7) percent at eight hundred (800) p.s.i. average unit pressure.

(b) The shear resistance of the bearing shall not exceed fifty (50) p.s.i. for fifty (50) durometer, seventy-five (75) p.s.i. for sixty (60) durometer, or one hundred ten (110) p.s.i. for seventy (70) durometer at twenty-five (25) percent strain of the total effective neoprene thickness after an extended four (4) day ambient temperature of minus twenty (20) degrees Fahrenheit.

In addition to the certification of subsection 725.02.01 the Department, at its option, may conduct its own tests on the material. If the Department should

elect to perform tests on the material, the Contractor shall furnish sample pads and/or fabric at his own expense. A fabric sample not less than thirty-six (36) inches by forty-five (45) inches shall be submitted for testing from each new lot of fabric used in manufacturing the bearing pads. A sample pad not less than six (6) inches by twelve (12) inches in size shall be submitted for testing from each lot of pads or batch of elastomer to be furnished. The samples will be selected at random by the Department or its authorized representative at the point of manufacture or at the jobsite, at the option of the Department. Samples taken at the jobsite shall consist of complete pads as detailed on the plans, and the Contractor shall furnish additional complete pads to replace those taken for testing. The Contractor shall provide the Department with written notification thirty (30) days prior to the start of bearing production at which time the Department will decide whether to sample the materials.

SECTION 726

ROADSIDE MATERIALS

SCOPE

726.01.01 Materials Covered. This specification covers the materials used in erosion control, landscaping, and irrigation systems.

REQUIREMENTS

726.02.01 Certificates and Samples. (a) Topsoil. The Contractor shall obtain from the county weed control agency or the State Quarantine Officer a written certification that the area from which the topsoil is to be obtained is free from noxious weeds. Topsoil that has been treated with herbicides or sterilants shall be tested by the State Department of Agriculture to determine the residuals in the soil.

Before imported topsoil is brought on the jobsite, the Contractor shall furnish a current report from a recognized testing laboratory indicating the particle size, clay content, the pH factor, and electrical conductivity of the sample.

(b) Fertilizer. The fertilizer containers shall have the manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and federal laws. The State Department of Agriculture shall sample the fertilizer prior to use on the project.

(c) Humus. Before bulk humus is brought to the jobsite, the Contractor shall furnish a current report from a recognized testing laboratory indicating the moisture retention capacity, organic matter (based on dry weight), mineral matter (ash), silica (acid insoluble ash), nitrogen (based on dry weight), pH factor, and the amount of Douglas Fir bark.

(d) Plants. All plants shall comply with federal and State laws requiring inspection for plant diseases and infestations. Inspection certificates required by law shall accompany each shipment of plants, and certificates shall be delivered to the Engineer. All shipments of pines will be accompanied by certificates for USDA Quarantine No. 63 for White Pine blister rust, and Nevada Quarantine No. 54.05 for European Pine shoot moth.

(e) Seeds. The Contractor shall furnish to the Engineer duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within six (6) months before the date of delivery on the project. The State Department of Agriculture shall random sample and test seed prior to use on the project.

(f) Irrigation Materials. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Department. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

All materials shall be approved prior to use.

PHYSICAL PROPERTIES AND TEST

726.03.01 Topsoil. Topsoil shall consist of fertile, friable soil of loamy character, and shall contain an amount of organic matter normal to the region. It shall be obtained from well-drained arable land and shall be reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than one (1) inch in largest dimension, coarse sand, sticks, brush, litter, and other deleterious substances. Topsoil shall be capable of sustaining healthy plant life.

Requirements for topsoil shall be as follows:

Particle Size	3/8 inch max.
Clay Content	20 percent max. (by weight)
pH Factor	6.4 to 7.4
Electrical Conductivity	0.5 to 1.0 mmhos. per centimeter of the saturation paste extract

726.03.02 Fertilizer. Fertilizer shall be a standard commercial grade of organic or inorganic fertilizer of the kind and quality specified in the contract documents. It may be separate or in a mixture containing the percentage of total nitrogen, available phosphoric acid and water-soluble potash in the amounts specified. All fertilizers shall be furnished in standard unopened containers with weight, name of plant nutrients, and manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and federal laws.

Acceptable commercial fertilizer will be specified in one (1) of the following forms:

(a) A dry free-flowing granular fertilizer, suitable for application by agricultural fertilizer spreader.

(b) A soluble fertilizer ground to a fineness that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.

(c) A granular or pelleted fertilizer, suitable for application by blower equipment.

(d) A nonvolatile liquid fertilizer.

726.03.03 Humus. Humus shall be processed, composted, fine ground bark of White Fir, Pine, or Redwood, or a mixture of these in any proportion. Humus shall be free of lumps and/or clods and shall be fine enough so that one hundred (100) percent of the material will pass a one-half (1/2) inch screen, and eighty-five (85) percent will pass a No. 6 screen.

Requirements for humus shall be as follows:

Moisture retention capacity	35 percent min.
Organic matter based on dry weight	95 percent min.
Mineral Matter (ash)	5 percent max.
Silica (acid insoluble ash)	3 percent max.
Nitrogen based on dry weight	0.8 percent min.
pH Value based on 1:5 solution	4.0 to 6.0
Douglas Fir Bark	0 percent

726.03.04 Mulch. (a) Hay or Straw. All hay or straw mulch materials shall be in an air-dried condition free of noxious weeds, weed seeds, and

other materials detrimental to plant life. Unless otherwise specified in the contract documents, hay or straw mulch material shall be of approved field grasses indigenous to the area. The Contractor shall obtain from the State Department of Agriculture a written certification that the hay or straw is free of noxious weeds.

(b) Wood Cellulose Fiber. Wood cellulose fiber mulch shall be specially processed wood fiber containing no growth or germination inhibiting factors and shall be dyed a suitable color to facilitate inspection of the placement of the material.

Mulch shall also conform to the following requirements:

Moisture Content	12.0% ± 3.0%
Organic Matter (Oven-Dried Basis)	99.6% ± 0.2%
Ash Content	0.8% ± 0.2%
Water Holding Capacity (Grams of Water/100 Grams of Fiber)	1080 minimum

(c) Wood Chips and Shavings. Shavings shall be manufactured from any clean soft wood.

Wood chips shall be manufactured from any clean, green softwood. Chips from kiln-dried or air-dried material will not be accepted. Chips shall be produced by machinery equipped with knives or blades which cut rather than shred or break the material. Chips shall be graded so that substantially all chips are from one-half (1/2) inch to three (3) inches in length, one-half (1/2) inch to one and one-half (1 1/2) inches in width and from one-eighth (1/8) inch to one-half (1/2) inch in thickness.

Chips produced from tree trimmings which contain leaves or small twigs will not be accepted.

726.03.05 Erosion Control Fabric. Erosion control fabric shall be as specified in the contract documents.

(a) Length approximately fifty (50) yards.

(b) Matting width shall be forty-eight (48) inches with an average weight of ninety-two one-hundredths (0.92) pound per square yard. A tolerance of plus or minus one (1) inch in width and five (5) percent in weight will be allowed.

726.03.06 Plants. All plants shall be first-class nursery grown representatives of their normal species and shall be true to type or name as shown on the plans and shall conform to the American Standard for Nursery Stock, No. 1 grade, American Association of Nurserymen, Inc., latest edition, ASA Spec. Z 60.1 and shall be tagged in accordance with the most recent standard practice recommended by the American Association of Nurserymen and to the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.

726.03.07 Seeds. Grasses, legumes, or cover crop seed shall be furnished in standard containers on which shall be shown the following information:

(a) Seed name.

(b) Lot number.

(c) Net weight.

(d) Percentage of purity.

(e) Percentage of germination (in case of legumes, percentage of germination to include hard seed).

(f) Percentage of weed seed content and inert material clearly marked for each kind of seed in accordance with applicable State and federal laws.

(g) No noxious weed seed present.

Seed which has become wet, moldy or otherwise damaged in transit or storage will not be accepted. Seed shall be at least ninety-five (95) percent pure and shall have a minimum of eighty-five (85) percent germination.

726.03.08 Tree Ties. Tree ties shall be strips of vinyl coated nylon, durable, nonhardening long-life material approximately one (1) inch wide and approximately ten (10) mils thick, or other suitable material approved by the Engineer.

A number ten (10) gage galvanized wire encased in at least one-half (1/2) inch black rubber hose may be used when permitted by the Engineer.

726.03.09 Pipe and Fittings. Pipe shall be standard weight, hot dipped galvanized iron or steel pipe, threaded and coupled. Pipe shall meet the current requirements of ASTM Designation A120, and shall be furnished in standard lengths. All pipe fittings shall be standard threaded galvanized malleable iron fittings.

Plastic pipe, except soaker lines, shall be polyvinyl chloride (PVC) 1120 or 1220 pressure pipe as shown in the irrigation system legend on the plans, and shall conform to the requirements of ASTM Designation D1785. All PVC pipe shall be extruded from one hundred (100) percent virgin material, and shall be National Sanitation Foundation (NSF) approved. All plastic pipe, except soaker lines, shall be Class 200. Bell and spigot PVC pipe may be used in lieu of plain end pipe and couplings.

Fittings for PVC plastic pipe shall be rigid polyvinyl chloride, Standard Weight, Schedule 40, and shall be solvent weld type except as shown on plans. Fittings for PVC pipe shall have higher bursting pressure than the pipe.

Polyethylene used in the manufacture of polyethylene fittings shall conform to ASTM Designation D1248, for Type III. Polyethylene fittings used in assembling swing joint risers shall be schedule 80 conforming to ASTM Designation D2611.

Plastic pipe for soaker lines shall be flexible polyvinyl chloride (PVC) conforming to ASTM Designation D2287. This material shall have a Shore Durometer hardness, A scale, of ninety (90) to ninety-nine (99) and a specific gravity of one and four-tenths (1.4) to one and forty-four one-hundredths (1.44).

All PVC plastic pipe shall be homogeneous throughout and shall be smooth inside and outside, free from cracks, holes, foreign materials, dents, wrinkles, and blisters.

726.03.10 Conduit for Future Irrigation Systems. The conduit shall be polyvinyl chloride (PVC) pipe conforming to ASTM Designation D3034, S.D.R.35.

726.03.11 Blank.

726.03.12 Blank.

726.03.13 Masonry. Hollow load-bearing concrete masonry blocks shall conform to the requirements of ASTM Designation C90.

Hollow nonload-bearing concrete masonry blocks shall conform to the requirements of ASTM Designation C129.

SECTION 727

CONCRETE SURFACE FINISHING MATERIAL

SCOPE

727.01.01 Materials Covered. This specification covers the types and quality of concrete surface finishing materials.

PHYSICAL PROPERTIES AND TESTS

727.02.01 Requirements. Bonded grout finishing material shall conform to the following requirements:

(Except as noted herein tests shall be made in accordance with test method indicated. Federal standard test methods are as contained in Publication Federal Test Methods Standard No. 141.)

(a) Viscosity—one hundred ten (110) to one hundred fifteen (115) K.U., Using pin paddle. (Federal Standard Method No. 4281.)

(b) Total solids (Federal Standard Method No. 4042):

1. By weight—sixty-five (65) percent min.
2. By volume—Forty-eight (48) percent min.

(c) Flexibility—Pass one (1) inch mandrel when spread twelve (12) mils wet on a tin panel, air dried sixteen (16) hours and oven dried sixteen (16) hours at one hundred twenty (120) degrees Fahrenheit. Panel shall show no mud cracking or no loss in adhesion to the panel when bent. (Federal Standard Method No. 6221.)

(d) Water resistance—No softening when tested as follows: Spread a twelve (12) mil film on tin panel, allow to air dry forty-eight (48) hours. Immerse in water for sixteen (16) hours, and allow to dry for eight (8) hours. There shall be no effect on the material. (ASTM D1647.)

(e) Weatherometer durability—Expose a twelve (12) mil film applied to asbestos-cement board for five hundred (500) hours in an Atlas Twin-Arc weatherometer. There shall be no erosion, cracking, softening, or other visible defects in the coating. (Federal Standard Method No. 6152.)

SECTION 728

EPOXY

SCOPE

728.01.01 Materials Covered. These specifications are intended to specify epoxy that will meet service requirements for highway construction.

Epoxy shall be furnished as two (2) components which shall be mixed together at the site of the work.

REQUIREMENTS

728.02.01 Sampling and Testing. Epoxy shall not be used prior to sampling and testing unless its use is permitted prior to said sampling and testing in accordance with the provisions in subsection 106.05, "Certificates of Compliance."

All tests will be conducted in accordance with the latest test methods of the American Society for Testing and Materials, Federal Test Method Standard No. 141, and methods in use by the Department of Transportation.

728.02.02 Certificates. Without expense to the Department, two (2) certificates covering each order of material shall be furnished by the manufacturer, certifying that the product complies with the specifications. Certificates shall be delivered to the Engineer in charge at the jobsite at the time of, or prior to, delivery of the order.

728.02.03 Packaging, Labeling, and Storing. Each component shall be packaged in steel containers not larger than five (5) gallons in volume. When the components are to be mixed at a ratio of two (2) parts A to one (1) part B, by volume, the container containing component B shall be one-half (1/2) the volume of the container containing component A. The containers shall have lug type crimp lids with ring seals, shall be new, not less than twenty-four (24) gage, shall otherwise meet United States Department of Transportation Hazardous Materials Shipping Regulations, and shall be well sealed to prevent leakage. If a lining is used in the containers, it shall be of such character as to resist any action by the components. Each container shall be clearly labeled with the designation (component A or B), type (standard or rapid), if applicable, manufacturer's name, date of manufacture, batch number (a batch shall consist of a single charge of all components in a mixing chamber), all directions for use specified elsewhere, and the following warning:

CAUTION

This material will cause severe dermatitis if it is allowed to come in contact with the skin or eyes. Use gloves and protective creams on the hands. Should this material contact the skin, wash thoroughly with soap and water. Do not attempt to remove this material from the skin with solvents. If any gets in the eyes, flush for ten (10) minutes with water and secure immediate medical attention.

Attention is directed to the characteristic of some epoxy components to crystalize or thicken excessively prior to use when stored at temperatures below thirty-five (35) degrees Fahrenheit. Any material which shows evidence of crystallization or a permanent increase in viscosity or settling of pigments which cannot be readily redispersed with a paddle shall not be used.

728.02.04 Directions for Use. At the time of mixing, components A and B shall be at a temperature between sixty (60) degrees Fahrenheit, and eighty-five (85) degrees Fahrenheit, unless otherwise specified. Any heating of the adhesive components shall be done by application of indirect heat. Immediately prior to mixing, each component shall be thoroughly mixed with a paddle. Separate paddles shall be used to stir each component. Immediately prior to use, the two (2) components shall be thoroughly mixed together in the specified ratios. When mixed, all adhesives shall have a uniform gray color without black or white streaks. No solvent shall be added to any epoxy.

After mixing, all epoxies shall be placed in the work and any overlaying or inserted material which is to be bonded to the work by the epoxy shall also be placed before thickening of the epoxy has begun. Surfaces upon which epoxy is to be placed shall be free of rust, paint, grease, asphalt, and loose and deleterious material. When epoxy is used as a binder to make epoxy concrete or mortar, the two (2) components of epoxy shall be thoroughly mixed together before the aggregate is added and, unless otherwise specified, the mix proportions shall consist of one (1) part of binder to approximately four (4) parts of aggregate, by volume. Aggregate for use in epoxy concrete and mortar shall be clean and shall have a moisture content of not more than five-tenths (0.5) percent when tested by Test Method No. Nev. 112. All surfaces against which epoxy concrete and mortar are to be placed shall be primed with a coat of the epoxy used just prior to placing the mortar.

TYPES OF EPOXIES

728.03.01 Binder (Adhesive), Epoxy Resin Base. This specification covers a two (2) component, low viscosity, resin base epoxy designed primarily for use as a binder in making epoxy concretes or epoxy mortars, and for fastening metal anchors in vertical holes in concrete, and in pressure grouting of cracks in concrete.

The epoxy shall conform to the requirements of ASTM C881, Type III, Grade 1, Class A, B, or C; or AASHTO M235, Class III, low viscosity version.

728.03.02 Blank.

728.03.03 Epoxy Resin Adhesive for Bonding New Concrete to Old Concrete. This specification covers two (2) component, epoxy resin bonding systems for use in bonding new Portland cement concrete to old Portland cement concrete, and in fastening metal anchors in horizontal holes in concrete. The epoxy is specified in two (2) types: Type I for general use and Type II for use when curing temperatures are below sixty (60) degrees Fahrenheit, or when a faster cure is required.

Type I shall conform to the requirements of ASTM C881, Type II, Grades 1, 2, or 3, Class C; or AASHTO M235, Class III.

Type II shall conform to the requirements of ASTM C881, Type II, Grades 1, 2, or 3, Class A or B. (Class A is designed for use below forty (40) degrees Fahrenheit, Class B is designed for use between forty (40) and sixty (60) degrees Fahrenheit.)

728.03.04 Rapid Set Epoxy Adhesive for Pavement Markers. Epoxy used under this specification shall conform to the requirements of AASHTO M237, Class II, Type I or I–M. Type I is intended for hand mixing and application. Type I–M is designed for use with automatic metering, mixing, and application equipment. Choice of the type to be used shall be at the option of the Contractor unless otherwise directed by the Engineer.

Tests for requirements contained in AASHTO M237 shall be performed in accordance with AASHTO T237.

728.03.05 Standard Set Epoxy Adhesive for Pavement Markers. Epoxy used under this specification shall conform to the requirements of AASHTO M237, Class II, Types II, II–M, III, or III–M. Types II and III are designed for hand mixing and application. Types II–M and III–M are designed for use with automatic metering, mixing, and application equipment. Types II and II–M are designed as medium setting adhesives with an approximate set time of two (2) hours at seventy-seven (77) degrees Fahrenheit. Types III and III–M are designed as standard setting adhesives with an approximate set time of four (4) hours at seventy-seven (77) degrees Fahrenheit. Choice of the type to be used shall be at the option of the Contractor unless otherwise directed by the Engineer.

Tests for requirements contained in AASHTO M237 shall be performed in accordance with AASHTO T237.

728.03.06 Blank.

728.03.07 Blank.

728.03.08 Blank.

728.03.09 Epoxy Sealant for Inductive Loops.

Classification:

This specification covers a high viscosity liquid epoxy formulated primarily for use in sealing inductive wire loops and leads imbedded in asphalt concrete and Portland cement concrete for traffic signal controls and vehicle counters. This epoxy is to be used for repair work on existing spalls, cracks, and other deformations in and around saw cuts housing inductor loops and leads. The rapid cure allows minimum traffic delay. This sealant is suitable for use in freeze-thaw areas and can be used on grades up to fifteen (15) percent without excessive flow of material.

Composition:

Component A

	Parts by Weight
Epoxy Resin[1]	85.00
Orthocresol Glycidyl Ether[2]	15.00
Titanium Dioxide, ASTM Designation D476, Type III or IV	2.00
Colloidal Silica[3]	1.50
Glycerine, ASTM Designation D1257	0.50
Silicone Anti-Foam, Type Q	0.01

Component B

	Parts by Weight
High Functionality Polymercaptan Hardener[4]	40.00
N-Aminoethyl Piperazine[5]	10.00
2, 4, 6-Tri (Dimethylaminomethyl) Phenol[6]	4.00
Polysulfide Polymer[7]	48.94
Colloidal Silica[3]	1.00
Glycerine, ASTM Designation D1257	0.50
Carbon Black[8]	0.10
Silicone Anti-Foam, Type Q	0.01

[1]Di glycidyl ether of bisphenol A, viscosity, 100–600 poise at 25° Centigrade, epoxide equivalent 180–200. Color, Gardner 1933, 3 max.

[2]Viscosity at 25° Centigrade, 510 centipoise, weight per gallon 9.00–9.10 pounds. Epoxide equivalent 180–200.

[3]SiO_2 (moisture-free basis), 99 percent minimum; refractive index, 1.46; surface area 175–225 square meters per gram; particle size 0.015 microns; pH (4 percent aqueous dispersion), 3.5–4.2; pour density, 2.3 lbs./cu. ft. maximum; free moisture at 105° Centigrade, 1.0 percent maximum.

[4]Liquid polymercaptan resin, viscosity 100–130 poise at 25° Centigrade; specific gravity 1.14–1.16; mercaptan value, 3.6 meq./gram. Color, Gardner 1933, 1. Infrared curve shall match the curve on file in the Department of Transportation.

[5]Color (APHA) 50 maximum; amine value 1250–1350 based on titration which reacts with the 3 nitrogens in the molecule; appearance clear and substantially free of suspended matter.

[6]Formula weight 265; specific gravity at 25°/25° Centigrade, 0.973; refractive index 1.514 at 25° Centigrade; distillation range 96 percent at 130° Centigrade to 160° Centigrade (0.5–1.5 mm.); flash point, Tag. open cup, 300° Fahrenheit minimum; water content 0.06 percent maximum.

[7]Specific gravity, 1.24–1.30 at 20°/20° Centigrade; viscosity, 700–1200 centipoise, Brookfield at 25°C.; pH water extract, 6.08.0; moisture content, 0.1 percent maximum; pour point, —15°F.; average molecular weight, 1000; flash point, Fahrenheit, Cleveland Open Cup, 390 minimum; sulfur content, percent, 36–40; color, Hellige, 9–12. The product shall be a difunctional mercaptan made from 98 mole percent of bis (2-chloroethyl) formal and 2 mole percent of trichloropropane.

[8]Surface area, square meters/gram, 80–150; particle diameter, millimicrons, 18–30; pH, 7.0–8.5; fixed carbon (moisture free), percent, 96–98; volatile matter, percent, 1–4; oil absorption, stiff paste endpoint, CCS/gram, 0.75–0.90.

Tests:

All tests shall be performed in accordance with Test Method No. Nev. T501.

Characteristics of Components:

Component A

Viscosity, poise, Brookfield	100–250
Shear Ratio	2.0 min.

Component B

Viscosity, poise, Brookfield	100–250
Shear Ratio	1.8 min.

Infrared curves of the vehicle components shall match those on file in the Department of Transportation.

Characteristics of Combined Components:

Gel Time	13–18 minutes on 1/8" cast sheet, cured 18 hours at 77° Fahrenheit +5 hours at 158° Fahrenheit—
Tensile Strength, p.s.i.	400 min.
Elongation, percent	90 min.
Shore D Hardness	45 min.

Color to range from Color No. 26081 to Color No. 26173 of Federal Standards No. 595.

Directions for Use:

Saw cuts shall be blown clean and dry with compressed air to remove all excess moisture and debris. For repairing damaged saw cuts, all loose spalled material shall be cleaned away from saw cut, chipping back to sound asphalt concrete or Portland cement concrete and all loose material cleaned from loop wire.

The mixing ratio is one (1) part by volume of Component A to one (1) part by volume of Component B. No more material shall be mixed that can be used within ten (10) minutes from the time mixing operations are started.

SECTION 729

TRAFFIC PAINT

SCOPE

729.01.01 Material Covered. These specifications cover ready mixed traffic line paint to be applied to either asphaltic or Portland cement concrete pavements.

REQUIREMENTS

729.02.01 General. Paint shall be free from foreign materials, such as dirt, sand, fibers from bags, or other material capable of clogging screens, valves, pumps, or other equipment used in a paint striping apparatus. The paint pigment shall be well ground and shall be properly dispersed in the vehicle. The dispersions shall be of such nature that the pigment does not cake or thicken in the container, and does not become granular or curdled. Any settlement of pigment in the paint shall be a thoroughly wetted, soft mass permitting the complete and easy vertical penetration of a paddle. Settled pigment shall be easily redispersed, with minimum resistance to the sidewise manual motion of the paddle across the bottom of the container, to form a smooth uniform product of the proper consistency.

The specified amounts and materials used in each formula for achieving satisfactory pigment wetting and suspension, may be varied or changed to suit the vendor's method of manufacture. Paint made with any deviations in antisettling, wetting agents, or stabilizers shall still be required to conform to the characteristics of the finished paint and all other requirements of these specifications.

729.02.02 Packaging. All manufactured paint shall be prepared at the factory ready for application. The addition of thinner or other material to the paint after the paint has been shipped will not be permitted unless otherwise specified in the contract special provisions.

All shipping containers must comply with Department of Transportation Code of Federal Regulations, Hazardous Materials Regulations Board, Reference 49 CFR. The containers must be lined, if necessary, so as to prevent attack by the paint or agents in the air space above the paint. The lining must not come off the container or lid as skins.

All containers shall be properly sealed with suitable gaskets and shall show no evidence of leakage.

All containers of paint shall be labeled showing the exact title of the specification, manufacturer's name, date of manufacture, and manufacturer's batch number.

Precautions concerning the handling and application of paint shall be shown on the label of the paint container.

The lining of the containers shall be of such character as to resist the solvent of this paint and to permit no skins being loosened into the body of the paint.

PHYSICAL PROPERTIES AND TESTS

729.03.01 Sampling and Testing. Samples will be taken after delivery. The State of Nevada reserves the right to have an inspector present to observe the manufacturing process. The vendor shall furnish a complete formulation record of his manufacturing process to the Materials and Testing Division.

All tests shall be performed according to ASTM, Federal Test Method Standard No. 141a, and methods designated by the Materials and Testing Division of the Nevada Department of Transportation.

729.03.02 Materials. The raw materials for use in the paint formula shall conform to the specifications designated by federal serial number or paint material code number hereinafter specified. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products.

Paint shall also comply with the following requirements:

FAST DRY TRAFFIC PAINT

1.1 Composition Requirements. All percentages specified are by weight.

1.1.1 Pigment Composition. Percent by weight of total pigment:

	White	Yellow
Titanium Dioxide, Anatase (ASTM D476, Type I, 94 percent min. TiO_2)	24.0–26.0	7.0–9.0
Medium Chrome Yellow (ASTM D211, Type III, 87 percent min. $PbCrO_4$)	.....	15.0–17.0
Zinc Oxide (ASTM D79, American Process-Type)	7.5–9.5	7.0–9.0
Magnesium Silicate (ASTM D605)	26.0–38.0	35.0–37.0
Calcium Carbonate (ASTM D1199, Type GC, Grade I or II)	28.0–30.0	31.0–33.0
Antisettling Agent (Bentone 34 or Claytone 40)	Note 1	Note 1

NOTE 1. Sufficient dispersing and suspending agent shall be added to prevent excessive settling as required in 2.2 and 2.4.

1.1.2 Vehicle Composition. Percent by weight of vehicle:

	White and Yellow
Alkyd Resin Solution (See Note 2)	21.3 min.
Chlorinated Rubber (Parlon S20 or Alloprene X20)	16.4 min.
Chlorinated Paraffin (Federal Specification MIL–C 429C, Type I)	11.3–13.3
Lead Drier 24 percent (ASTM D600, Class B)	0.2–0.4
Cobalt Drier 6 percent (ASTM D600, Class B)	0.05–0.25
Antiskinning Agent (Exkin or Equivalent)	Note 3

	White and Yellow
Stabilizer (Propylene Oxide) (See Note 4)	0.45–0.55
Toluene (ASTM D362)	26.1 max.
Heptane (Technical Grade)	6.5–8.5
Methyl Ethyl Ketone (ASTM D740)	14.7 min.
Methanol (ASTM D1152)	0.2–0.4

NOTE 2. Alkyd Resin Solution: The medium oil soya-modified alkyd resin shall be supplied as fifty-nine (59) to sixty-one (61) percent nonvolatile solids in VM & P Naphtha (TT-N95b, Type I). The resin solids shall contain an oil acid content of forty-eight (48) to fifty-five (55) percent, a phthalic anhydride content of thirty-three (33) to thirty-seven (37) percent and an acid number of eight (8) maximum. The alkyd resin solution shall have a maximum color of nine (9) (Gardner). The alkyd resin solution, reduced to forty-five (45) percent solids with VM & P Naphtha, shall have a viscosity of D to G (Gardner-Holdt). No rosin will be permitted. The oil fatty acids shall be of vegetable origin, either alkali refined soya bean oil or the fatty acids of soya bean oil having a minimum iodine number of one hundred fifteen (115). No recovered oil marine or soya food fatty acid derivatives shall be used. The alkyd resin solution must tolerate a five hundred (500) percent by weight dilution with VM & P Naphtha. A solution containing alkyd resin solution, chlorinated rubber, methyl ethyl ketone, toluene and heptane in the proportions given in the vehicle composition shall be clear, transparent and show no separating after storage of twenty-four (24) hours in a three-fourths (3/4) full test tube at twenty-six and seven-tenths (26.7) degrees plus or minus two and eight-tenths (2.8) degrees Centigrade (eighty (80) degrees plus or minus five (5) degrees Fahrenheit).

NOTE 3. Sufficient antiskinning agent shall be used to prevent skinning as required in 2.3. Material shall be added at the proper time during the manufacturing of the paint so as to minimize losses due to volatilization and maximize retention in the packaged product.

NOTE 4. Other approved stabilizers: Styrene Oxide—three (3) pounds per one hundred (100) gallons of paint; Thermolite 813—five-tenths (0.5) pound per one hundred (100) gallons of paint.

1.1.3 Manufacturing Formulations. Typical formulas which may serve as a guide for the paint manufacturer are as follows (Yields are approximately one hundred (100) gallons):

	Pounds	
	White	Yellow
Titanium Dioxide	150	50
Medium Chrome Yellow	------	100
Zinc Oxide	50	50
Magnesium Silicate	225	225
Calcium Carbonate	175	200
Antisettling Agent (Claytone)	4	4
Methanol	2	2
Alkyd Resin Solution (60 percent nonvolatile)	130	130
Chlorinated Rubber (Parlon S-20)	100	100
Chlorinated Paraffin	75	75
24 Percent Lead Drier	2	2
6 Percent Cobalt Drier	1	1
Antiskinning Agent (Exkin)	3	3
Stabilizer (Propylene Oxide)	3	3
Toluene	160	160
Heptane	45	45
Methyl Ethyl Ketone	90	90
	1215	1240

1.2 Quantitative requirements of mixed paint.

	White	Yellow
1.2.1 Pigment.		
Percent by weight	49.0–51.0	50.0–52.0
1.2.2 Total Solids.	White	Yellow
Percent by weight, min.	68.87	69.48
1.2.3 Nonvolatile Vehicle.	White	Yellow
Percent by weight vehicle, min.	38.96	38.96
1.2.4 Consistency.	White	Yellow
Krebs-Stormer Shearing rate 200 r.p.m.—		
Grams	140 to 190	140 to 190
Equivalent K.U.	70 to 80	70 to 80

	White	Yellow
1.2.5 Weight per Gallon.		
Pounds, min.	12.05	12.25
1.2.6 Fitness of Grind.		
Hegman gauge, North Standard Scale, min.	2	2
1.2.7 Drying Time.		
Minutes, max.	10	10
1.2.8 Directional Reflectance.		
Min.	80	50
1.2.9 Uncombined Water.		
Percent by weight of paint, max.	1.0	1.0
1.2.10 Coarse Particles and Skins.		
Retained on a No. 325 mesh sieve, percent by weight of pigment, max.	1.0	1.0

QUALITATIVE REQUIREMENTS OF FAST DRY TRAFFIC PAINT

2.1 Color of yellow paint. The color of the yellow paint shall visually match color chip No. 33538 of Federal Standard 595a when tested as specified in 3.1.5. In case of dispute, the color shall be within the green and red tolerance limits when compared with the standard color ships of "Highway Yellow Color Tolerance Chart," U.S. Department of Commerce, Bureau of Public Roads PR Color No. 1, June 1965.

2.2 Condition in container. The paint shall not show excessive settling in a freshly-opened full can and shall be easily redispersed with a paddle to a smooth homogeneous state. The paint shall show no curdling, livering, caking, gelling, or thixotropic properties, lumps, skins, or color separation. (See 2.3 and 2.4.)

2.3 Skinning. The paint shall not skin within forty-eight (48) hours in a three-fourths (3/4) filled, tightly closed container.

2.4 Storage stability. When stored for twelve (12) months the paint must be usable; the drying time shall be as specified and the consistency range shall be seventy (70) to eighty-five (85) Krebs units.

2.5 Flexibility and adhesion. The paint shall show no cracking, flaking, or loss of adhesion when tested as specified in 3.1.2.

2.6 Water resistance. The paint shall show no softening, blistering, loss of adhesion, or other evidence of deterioration other than a slight loss in gloss when tested as specified in 3.1.3.

2.7 Dilution stability. The thinned paint shall be uniform and show no separation, curdling, or precipitation after reduction in the proportions of

eight (8) parts by volume of the packaged material with not more than one (1) part by volume of the appropriate thinner for each type of paint.

2.8 Spraying properties. The paint as received or diluted no more than as specified in 2.8 shall have satisfactory spraying properties when applied (and held in a horizontal position) to tinplate or aluminum surfaces at a wet film thickness of approximately fifteen one-thousandths (0.015) inch.

2.9 Appearance. The sprayed film (see 2.8) shall dry to a smooth uniform finish free from roughness, grit, unevenness, and other surface imperfections. The paint shall show no streaking or separation when placed on clean glass.

2.10 Bleeding. The paint shall show a minimum rating of six (6) when tested as specified in 3.1.4.

TEST PROCEDURES

3.1 Test Procedures. The tests indicated in Table I shall be conducted in accordance with Federal Test Method Standard No. 141a or ASTM method as indicated.

TABLE I. Test Methods

Test	Federal Test Method Standard No. 141a or ASTM Method	Section of this specification giving requirements	Section of this specification with further reference
Percentage of Pigment	4021	1.2.1	.....
Nonvolatile in Vehicle	4051	1.1.2	1.2.3
Consistency, Krebs-Stormer	4281	1.2.4	.....
Weight per Gallon	4184	1.2.5	.....
Water Resistance	6011	2.6	3.1.3
Condition in Container	3011.1	2.2	.....
Dilution Stability	4203	2.7	.....
Skinning	3021	2.3	.....
Fineness of Grind, Hegman	4411	1.2.6	.....
Directional Reflectance	6121	1.2.8	.....
Uncombined Water	4081	1.2.9	.....
Coarse Particles and Skins	4091	1.2.10	.....
Phthalic Anhydride	7021	1.1.2	.....
Oil Acids	7031	1.1.2	.....
Rubber Base Precipitate	5211.1	1.1.2	.....
Iodine Number of Oils and Fatty Acids	5061	1.1.2	.....
Flexibility and Adhesion	6221	2.5	3.1.2
Appearance of Paint	3011.1	2.9	.....
Color of Pigmented Coatings	4250	2.1	3.1.5
Drying Time	ASTM D711	1.2.7	.....
Bleeding	ASTM D969	2.10	3.1.4

3.1.2 Flexibility and adhesion. Apply a wet film thickness of five one-thousandths (0.005) inches with a film applicator to a three (3) by five (5) inch

panel weighting thirty-nine one-hundredths (0.39) to fifty-one one-hundredths (0.51) lbs./sq. ft., previously cleaned with benzene and lightly buffed with steel wool. Dry the paint film at seventy (70) degrees to eighty (80) degrees Fahrenheit in a horizontal position for eighteen (18) hours, then bake in an oven at one hundred twenty-two (122) degrees plus four (4) degrees Fahrenheit (forty-seven and eight-tenths (47.8) degrees Centigrade to fifty-two and two-tenths (52.2) degrees Centigrade) for two (2) hours, cool to room temperature for at least one-half (1/2) hour and bend over a one-half (1/2) inch diameter rod and examine, without magnification, as specified in 2.5.

3.1.3 Water resistance of paint. Apply a wet film thickness of fifteen one-thousandths (0.015) inches with a film applicator to a clean glass plate. Let dry in a horizontal position at room temperature (seventy (70) degrees to eighty (80) degrees Fahrenheit) for seventy-two (72) hours. Immerse one-half (1/2) the painted plate in distilled water at room temperature for eighteen (18) hours as specified in Method 6011 of Federal Test Method Standard No. 141, allow to air dry for two (2) hours and examine as specified in 2.6.

3.1.4 Bleeding. The bleeding characteristics shall be determined in accordance with ASTM D969. The test panels shall be evaluated according to ASTM D868, and the degree of resistance to bleeding shall have a numerical rating as specified in 2.10.

3.1.5 Color of yellow paint. Apply a wet film of fifteen one-thousandths (0.015) inch to a tin panel; let dry for twenty-four (24) hours and compare color as required in 2.1.

SECTION 730

TRAFFIC BEADS

SCOPE

730.01.01 General. The glass spheres shall lend themselves readily to firm embedment in the traffic paint when dropped on a freshly placed paint line. The embedment shall be of such character as to provide a highly reflectorized surface on the paint film with reserve reflectorizing capacity in the lower sections of the paint film. The reflection shall be effectively manifest to the operator of a motor vehicle when the headlights of the vehicle are played on the markings.

All glass beads shall have a moisture proof overlay consisting of water repellent material applied during the process of bead manufacture. The beads so treated shall not absorb moisture in storage, shall remain free of clusters and lumps and shall flow freely from dispensing and testing equipment.

PHYSICAL PROPERTIES AND TESTS

730.02.01 Requirements. A minimum of eighty-five (85) percent of the beads by count shall be colorless, true spheres, free of dark spots, milkiness, air inclusions, and surface scratches which involve a substantial part of any individual sphere.

When tested according to ASTM D1214 the beads delivered shall conform to the following gradation requirements:

Sieve No.	Percent Passing
30	100
50	20–60
70	5–20
100	0–7

The Index of Refraction shall be a minimum of one and five-tenths (1.5) by the oil immersion method utilizing tungsten light at twenty-five (25) degrees Centigrade.

After refluxing a fifty (50) gm. sample of beads in a Soxhlet Extractor for eight (8) hours with distilled water there shall be no more than a very slight reduction in luster or reflecting power of the beads.

The beads shall have a specific gravity of two and forty-four one-hundredths (2.44) to two and fifty-six one-hundredths (2.56) at twenty-five (25) degrees Centigrade.

The moisture content shall not exceed one one-hundredth (0.01) percent when tested at one hundred five (105) degrees Centigrade for three (3) hours.

Two (2) pounds of beads are added to a reserved unbleached cotton bag approximately ten and one-half (10½) inches by seventeen and one-half (17½) inches (thread count forty-eight (48) by forty-eight (48)). The sample is then immersed in distilled water at room temperature for thirty (30) seconds or until the spheres are completely covered. The sample is then removed and excess water removed by twisting the neck of the bag. After two (2) hours

with the bag suspended at room temperature the sample is thoroughly mixed and transferred to a clean, dry funnel (one hundred fifty (150) mm. top diameter, one hundred twenty (120) mm. depth and nine (9) to ten (10) mm. stem i.d.). The entire sample shall flow through the funnel with light tapping of the stem permissible only at the start of the test to initiate flow.

SECTION 731

ENGINEERING FABRICS

SCOPE

731.01.01 Materials Covered. Engineering fabrics shall include pavement reinforcing fabric and any additional fabric types that may be specified in the special provisions.

Engineering fabrics shall be placed in accordance with various sections of these specifications.

Engineering fabrics shall be furnished in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

REQUIREMENTS

731.02.01 Certificates. A Certificate of Compliance for each type of engineering fabric used on the project shall be furnished to the Engineer in accordance with subsection 106.05, "Certificates of Compliance."

PHYSICAL PROPERTIES AND TESTS

731.03.01 Pavement Reinforcing Fabric. Pavement reinforcing fabric shall be manufactured from polyester, polypropylene, or polypropylene-nylon material. The fabric shall be nonwoven, and shall conform to the following:

Weight, ounces per square yard, ASTM Designation D1910	3.0 to 8.0
Grab tensile strength (1-inch grip), pounds, min., ASTM Designation D1117	90
Elongation at break, percent, min., ASTM Designation D1117	40
Fabric thickness, mils., ASTM Designation D461	12 to 100

SECTION 732

PERMANENT PAVEMENT MARKING FILM

SCOPE

732.01.01 Material Covered. This specification covers the quality requirements for permanent pavement marking film.

REQUIREMENTS

732.02.01 Certificates. A Certificate of Compliance for the pavement marking film shall be furnished to the Engineer in accordance with subsection 106.05, "Certificates of Compliance."

PHYSICAL PROPERTIES AND TESTS

732.03.01 Permanent Pavement Marking Film. The film shall conform to the following requirements:

(a) Composition. The permanent pavement marking film shall be pliant polymer and shall consist of a mixture of polymeric materials, pigments, and glass beads uniformly distributed throughout its cross-sectional areas and with a reflective layer of beads bonded to the top surface. These materials shall be composed as follows:

	Minimum by Weight
Resins and Plasticizers	20 percent
Pigments	30 percent
Graded Glass Beads	30 percent

(b) Glass Bead. The glass beads shall be colorless and have a minimum index of refraction of one and five-tenths (1.5) when tested using the liquid oil immersion method.

(c) Reflectance. These markings shall have the following initial average reflectance value at two-tenths (0.2) degree and five-tenths (0.5) degree observation angles and eighty-six (86) degrees entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard No. 370.

	White		Yellow	
Observation Angle	0.2°	0.5°	0.2°	0.5°
Specific Luminance	550	380	410	250

(d) Thickness. The nominal thickness, excluding adhesive, shall be six one-hundredths (0.06) inch.

(e) Tensile Strength. The film shall have a minimum tensile strength of forty (40) pounds per square inch of cross section when tested according to ASTM D638–76. A sample six (6) inches by one (1) inch by six one-hundredths (0.06) inch shall be tested at a temperature between seventy (70)

degrees Fahrenheit and eighty (80) degrees Fahrenheit, using a jaw speed of twelve (12) inches per minute.

(f) Elongation. The film shall have a minimum elongation of seventy-five (75) percent when tested according to ASTM D638–76, using a jaw speed of twelve (12) inches per minute.

(g) Plastic Pull Test. A test specimen made the same size as in paragraph (b) shall support a dead weight of four (4) pounds for not less than five (5) minutes at a temperature between seventy (70) degrees Fahrenheit and eighty (80) degrees Fahrenheit.

(h) Pigmentation. The pigments shall be selected and blended to provide a marking film which is white or yellow conforming to standard highway colors through the expected life of the film.

(i) Effective Performance Life. The Permanent Pavement Marking Film, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. Although reflectivity is reduced by wear, the pliant polymer shall provide a cushioned resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting, or shrinkage throughout the useful life of the marking, and shall show no significant tearing, roll back, or other signs of poor adhesion.

These materials shall be capable of being adhered to asphaltic and/or Portland cement concrete by means of a pressure sensitive precoated adhesive or a liquid contact cement which is applied at the time of installation. Application shall be made according to the manufacturer's recommendation.

INDEX OF SUBJECTS

A

PAGE

Abandoned manholes, catch basins and inlets ... 98
Abandoned pipe lines ... 97
Abandoning detour ... 20
Abbreviations ... 1, 2
Abutments, backfill for ... 126
Abutting joints:
  Reinforced concrete pipe ... 401
  Steel structures ... 353
Acceptance and final payment ... 28, 29, 86, 87
Accommodations for public traffic (see also Maintenance—Of traffic) ... 545–549
  Barricades and warning signs ... 551–557
  Construction methods ... 545–548
  Description ... 545
  Detours ... 545
  Equipment rental ... 547
  Flaggers ... 545, 546
  General ... 547
  Maintain base ... 546
  Materials ... 545
  Measurement ... 548
  Payment ... 548, 549
  Pilot cars ... 546
  Temporary ... 19, 20
Additives, fertilizers and ... 149
Adjustment (see also Delays in completion of work; Extension—Of contract time):
  Claims for additional compensation ... 29
  Common carrier rates ... 81, 82
Admixtures:
  Air-entraining ... 607
  Concrete curing materials and ... 607–609
  Lightweight concrete ... 329
  Other than air-entraining ... 607
  Portland cement concrete ... 237, 262, 263
  Prestressed concrete members ... 324
Advertisement, defined ... 2
Agencies, federal ... 50
Aggregate base courses:
  Class A aggregates ... 165–167
    Spreading ... 165, 166
    Tolerance for Type 2 ... 167
    Watering and mixing ... 167
  Class B aggregates ... 166, 167
    Spreading ... 166, 167
    Watering ... 167
  Compaction ... 167
  Construction methods ... 165–167
  Description ... 165
  Materials ... 165

Aggregate base courses—*continued* PAGE
Measurement 168
Payment 168
Samples and tests 43–45
Subgrade preparation 165
Watering 167
Aggregate, formed exposed, finish; concrete structures 306, 307
Aggregate spreader, for surface treatment 231
Aggregates (see sections covering various items of work)
Aggregates, base:
Deficiencies 623
General requirements 623
Grading requirements, tables 624–626
Drain backfill 624
Type I, Class A 624
Type I, Class B 624, 625
Type II, Class A 625
Type II, Class B 625
Type III, Class A 625
Type III, Class B 626
Physical properties and tests 624–626
Plastic limits 623
Samples and tests 43–45
Aggregates, bituminous courses:
Commercial mineral filler 630
Deficiencies 628
General requirements 627
Materials covered 627
Physical properties and tests 628–630
Plantmix and roadmix bituminous base and surface, Types 1, 2 and 3 628, 629
Plantmix bituminous open-graded surface 629, 630
Plantmix surface, Type 4 629
Samples and tests 43–45
Sand blotter 630
Screenings 630
Aggregates, Portland cement products:
Coarse, requirements for 631–633
Fine, requirements for 634, 635
General requirements 631
Grout and mortar sand, requirements 635, 636
Handling of 46
Lightweight, requirements tables 633, 634
Lightweight, storage of 330
Stone for masonry and riprap 636
Aggregates, Portland cement treated base:
Requirement tables 626
Sampling of base courses 43–45
Agreement:
Supplemental 7, 17
With owner of source materials 34, 35, 39, 40
Air-entraining admixtures 607
Portland cement concrete 262, 263

	PAGE
Alterations:	
Contract	17, 18
Staging or sequence of operations	19
Altered quantities	17, 18, 29–31
Aluminum alloy:	
Barbed wire	693
Bolts for signs	674
Bridge rail, used in	647
Fabrication and handling of	348
Pipe	647
Shims	647
Tubing	647
Aluminum sheets:	
Culvert markers and guide posts	685, 686
Guardrail construction	683
Permanent signs	559, 560
Sign panels	670, 671
American Association of Nurserymen	1
American Association of State Highway and Transportation Officials	1
American Concrete Institute	1
American Institute of Architects	1
American Institute of Steel Construction	1
American Iron and Steel Institute	1
American National Standards Institute	1, 471
American Railway Association	1
American Railway Engineering Association	1
American Society for Testing and Materials	1, 471
American Society of Civil Engineers	1
American Society of Landscape Architects	1
American Society of Mechanical Engineers	1
American Standards Association	1
American Water Works Association	1
American Welding Society	1
American Wire Gage	1, 471
American Wood Preservers Association	1
Ammoniacal copper arsenite	451
Anchor assemblies:	
Concrete reinforcement	653
Downdrains	421, 422
Anchor bolts:	
Rail posts	364, 365
Signs	672–674
Anchorages:	
Prestressed concrete members	318, 319
Prestressing rinforcement and, testing	653
Angles, end connection	353
Anionic emulsified asphalts, specifications table	621
Annealing and stress relieving, steel structures	363
Annulment of award	16
Appeal from decisions of Engineer	23
Aprons, concrete	433–435
Archeological and historic studies	36

INDEX

PAGE

Archeological and paleontological objects, preservation of....39, 56
Artifacts, preservation of....39, 56
Asphalt cement:
- Average weights and volumes table....76
- Demerits schedule....615
- Requirements....612–615
- Road materials, specifications tables....613, 614

Asphalt emulsions:
- Anionic, specifications table for....621
- Cationic, specifications table for....620
- Measurement....76
- Temperature table....226

Asphalt for waterproofing and dampproofing....611
Assembly:
- Field....366
- Metal bin-type retaining walls....438
- Shop....352, 353
- Structural plate pipe....413

Assignees (see Subcontractors)
Assignment of contract....63, 64
Associated General Contractors of America....1
Association of American Railroads....1
Authority and duties of:
- Engineer....23, 27, 31, 69–71
- Inspector....26
- Resident Engineer....26, 57
- Superintendent....24, 25

Automatic controllers, irrigation systems....154
Average weights and volumes tables:
- Asphalt cement....76
- Asphaltic emulsion....76
- Liquid asphalt....76

Award:
- And execution of contract....15, 16
- Annulment....16
- Cancellation....15
- Contract, award of....15
- Defined....2
- Notice of award....15

B

Backfill:
- Abutments....126
- At culverts....127
- Compaction....126
- Construction methods....126, 127
- Defined....125
- Description....125
- Drain (see Drain backfill)
- Excavated materials, backfill with....97, 99, 100, 122
- Granular....125

Backfill—*continued* PAGE
Holes, backfill of ... 97
Irrigation systems ... 161
Materials ... 125
Measurement ... 127
Mechanically stabilized earth backfill ... 585–589
Payment ... 127, 128
Pits ... 97
Placing and compacting:
Abutments, piers, wingwalls and retaining walls ... 126
Bin-type retaining walls ... 127
Culverts ... 127
Water for ... 687
Backflow preventers, irrigation systems ... 156, 159
Bar steel reinforcement for concrete ... 651
Barbed wire ... 455, 693
Barrel of cement, defined ... 75
Barricades and warning signs ... 51, 551–557
Construction ... 675
Partial payments on ... 85
Temporary signs ... 555–557
Barrier rails, concrete structures ... 307–309
Permanent concrete barrier rail ... 307, 308
Portable precast concrete barrier rail ... 308, 309, 551–554
Bars:
Galvanizing of ... 657
High-strength steel bars ... 651–654
Lacing, for steel structures ... 353
Signs, bars for ... 656
Base courses, aggregates used in ... 43–46, 165–168, 623–626
Base or surface selected material (see Selected material)
Basements left by structure removal, backfill and compaction of ... 97
Bases (see sections for various items of work)
Basis of payment clause (see also sections for various items of work) ... 78
Batching plants for:
Bituminous plantmix pavements ... 190–193, 199
Portland cement concrete pavement ... 240–242
Beads, traffic ... 719, 720
Bearing and anchorage, steel structures ... 365
Bearing devices, concrete structures ... 297, 298
Bearing plates, galvanizing of ... 672
Bearings, steel structures ... 365
Bearing surfaces, steel structures ... 353
Bearing value and penetration of piles ... 380
Beginning of work ... 347
Steel mills ... 347
Bending reinforcing steel ... 337, 338
Bidders:
Award of contract (see also Award) ... 15
Bond ... 3, 16
Collusion among ... 12
Defined ... 2
Disqualification of ... 12, 13

Bidders—*continued* PAGE
Examination of plans....10, 11
Financial ability and experience, statement of.... 9
Licensing of.... 9
Material guaranty.... 13
Notice to Contractor.... 9
Prequalification.... 9
Proposal (see Proposal)
Bidding requirements and conditions....9–13
Bids (see also Bidders; Contractor; Proposal):
Combination or conditional.... 13
Irregular....11, 12
Price adjustments....17, 18
Rejection of....12, 13, 15
Bituminous binders, pay quantities.... 76
Bituminous courses, aggregates for....627–630
Bituminous materials....611–622
Asphalt cements....612–615
Demerit schedule.... 615
Contractor's responsibility for.... 611
Emulsified asphalt....619–622
Anionic emulsified asphalts.... 621
Cationic asphalt emulsions.... 620
Demerit schedule.... 622
Liquid asphalts....615–619
Demerit schedule.... 619
Physical properties and tests....611–622
Preparation of.... 198
Prime coat, materials for....225, 226
Refinery test report....611, 612
Samples and tests....43–45
Schedule of liquidated damages....78, 79
Seal coat, materials for....229, 230
Shipping notice.... 611
Surface treatment, materials for....231–233
Tack coat, materials for....223, 224
Waterproofing and dampproofing, asphalt for.... 611
Bituminous mixing plant requirements....189–196, 199, 200
For all plants....190, 191, 199, 200
For batching plants....191–193
For continuous mixing plants....193–196
Safety.... 191
Bituminous mixtures, hauling equipment for.... 196
Bituminous open-graded plantmix surface:
Aggregates for....629, 630
Construction methods....211, 212
Description.... 211
Joints.... 212
Materials.... 211
Measurement.... 212
Payment....212, 213
Rollers....211, 212
Samples and tests....43–45
Scored shoulders....211, 212

Bituminous open-graded plantmix surface—*continued* PAGE
Surface tolerances 212
Weather limitations 198
Bituminous pavement, removal of 98, 106, 107
Bituminous pavers 197
Bituminous plantmix base:
Aggregate requirements 627–629
Construction methods 169, 170
Description 169
Materials 169
Measurement 170
Payment 170
Rollers 169
Samples and tests 43–45
Spreading and finishing 169
Surface tolerances 169, 170
Weather limitations 198
Bituminous plantmix mixtures, composition of 187–189
Bituminous plantmix pavements (see Pavements, bituminous plantmix)
Bituminous plantmix surface:
Aggregates for 627–630
Construction methods 207–209
Description 207
Materials 207
Measurement 209, 210
Payment 210
Recycled plantmix bituminous surface 208, 209
Rollers 207
Samples and tests 43–45
Spreading and finishing 207
Surface tolerances 208
Weather limitations 198
Bituminous roadmix base, aggregates for 627–629
Bituminous roadmix surface:
Aggregates for 215–217, 627–629
Application of bituminous materials 217
Bituminous materials 215
Construction methods 215–220
Description 215
Distributors 215, 216
Existing surface:
Modification 181–184
Preparation of 216
Materials 215
Measurement 220, 221
Miscellaneous areas 219
Mixing 217, 218
Mixing plants 216
Motor graders 215
Payment 221, 222
Placing aggregates 216, 217
Premixed bituminous paving material 220
Rollers 216
Spreading, compacting and finishing 219

Bituminous roadmix surface—*continued* PAGE
Surface preparation 216
Surface tolerances 219, 220
Weather limitations 216
Bituminous surfaces, existing (see Existing surfaces)
Blasting:
Excavation 52, 102
Explosives, use of 54, 55
Fire patrol to be maintained under certain conditions 57
Removal of existing structures 97
Blotter material (see Sand blotter)
Bolts and bolted connections, steel structures 350–352
General 646
High strength 645
Nuts and washers, galvanizing of 657
For signs 672
Nuts, dowels and drift bolts 689
Stainless steel 645
Structural plate pipe 412
Bolts and washers, timber structures 371
Bonded grout finish, concrete structures 305, 306, 705
Bonds, contract 3, 16
Labor and material 16
Surety 7, 16
Borrow:
Contract agreement 105
Excavation and embankment 101, 102, 105, 106
Measurement for payment 115
Measurement of quantities 73
Overhaul 119, 120
Box culverts, precast concrete (see also Culverts) 309, 310
Boxes, planter 144
Boxes, valve, irrigation systems 156
Brace wire, fence material 694
Braces for:
Fence materials 691–693
Signs 674
Timber structures 372
Bridge:
Defined 2
Length, defined 2
Partial payments on bridge rail 85
Rail, aluminum for 647
Railings, paint for 655, 656
Roadway width, defined 2
Structural steel 646
Bridge deck:
Finishing 301–304
Repair 300, 301
Waterproofing 593–600
Bridges, concrete (see also Concrete structures):
Extensions of existing 98
Load and speed restrictions on new 28

Bridges, concrete—*continued* PAGE
Placing Portland cement concrete in 281
Railing, aluminum for 647
Removal of 97, 98
Steel (see Steel structures)
Timber (see Timber structures)
Bronze castings 649
Bronze disks for monuments 469
Brush, removal of 34, 91–95, 453
Buildings, removal and disposal of 93, 97–100
Burning prohibited 21, 57, 92

C

Calendar day, defined 2
Caps, timber structures 372
Carbon steel structural tubing 646
Cast aluminum alloy 647
Cast-in-place concrete plies 378, 383–388
Castings:
Bronze 649
Gray Iron 649
Iron and steel, painting of 449
Malleable 649
Steel 649
Catch basins, manholes and inlets:
Adjusting of covers 426
Clean out 426
Construction methods 425–427
Covers, concrete 426
Description 425
Earthwork 427
Grates 425, 426
Materials 425
Measurement 427
Payment 427, 428
Pipe or tile used in 426
Removal of 97, 98
Cattle guards:
Construction methods 459, 460
Description 459
Earthwork 459
Materials 459
Measurement 460
Paint for cattle guard wings 655
Painting 459, 460
Partial payment 86
Payment 460
Wings 459, 655
Cavities left by structure removal 97
Cement measurement 75
Cement, protecting and sampling 266, 268

	PAGE
Cement treated base:	
Aggregates for	626
Compaction	176
Construction joints	177
Construction methods	171–178
Curing, protection and	177, 178
Description	171
Finished surface	177
Materials	171
Measurement	178, 179
Plantmix method	179
Roadmix method	178, 179
Mixing:	
Plantmix method	173, 174
Roadmix method	171–173
Payment	179, 180
Plantmix method	180
Roadmix method	179, 180
Proportioning	171
Protection and curing	177, 178
Requirements, Portland cement	605
Spreading	174–176
Time requirements	177
Watering	133, 134, 176, 177
Weather limitations	178
Cement treated subgrade	605
"Low alkali" or "blended" cement used in	605
Certificates:	
Of compliance	45
Bonded grout finish	305
Bridge deck waterproofing material	595
Cement	268
Conduit	480
Culvert markers and guide posts	685
Elastomeric bearing pads	695
Engineering fabric	721
Epoxy	707
Fence materials	691
Guardrail materials	683
Landscaping materials	141, 142
Paint	655
Pavement marking film	723, 724
Roadside material	699, 700
Sign materials	659
Structural steel	345
Timber	679
Certificates of insurance	53, 54
Chain-link fencing	453–457
Drive gate for	694
Fabric	693
Change order	2, 17, 18, 29–31, 35, 36, 42, 79–81
Changes in character of work	17, 18, 29–31
Channel, defined	2
Channel excavation (see Ditch and channel excavation)	

PAGE
Character of workmen; methods and equipment....65, 66
Chief Engineer (railroad), defined....51
Chipping, reaming and cutting....366
Cited specifications....45, 46
Claims for adjustment and disputes....29
Classification and proportions:
Lightweight concrete....330–332
Portland cement concrete....268–272
Clearance markers, railroad....52
Clearing and grubbing:
Areas to be cleared....91–92
Burning of material not permitted....21, 57, 92
Construction methods....91–94
Disposal locations....92
Final clean up....20, 21
Measurement....94
Payment....94, 95
Rural clearing....93
Scalping....93
Structure excavation material....121, 123
Urban clearing....93
Coarse aggregates for Portland cement concrete....261, 631–633
Coating of reinforcing steel....336, 337
Cofferdams, concrete structures....289
Seal coarse of concrete under water....292, 293
Structure excavation....121
Cold-formed carbon steel structural tubing....646
Collusion among bidders....12
Columns, concrete structures....292
Combination bids (see also Bids)....13
Commencement of work....64
Preconstruction conference....67
Commercial mineral filler....630
Common carrier rate adjustments....81, 82
Compaction (see also Rollers and rolling):
Aggregate base courses....167
Backfill....125–127
Basements and cavities left by structure removal....97
Bituminous roadmix surface....219
Concrete placed in concrete structures....290, 291
Dirt embankment....109, 110
Drain backfill....131
Embankment....97, 109–112
Erosion control....136, 137
Foundation areas, watering of....133, 134
Foundation fill....129
Portland cement concrete pavement....245–247
Portland cement treated base....176
Roadbed modification....183
Rock embankment....110–112
Selected material....163, 164
Shouldering material....185
Topsoil, erosion control....136, 137

Compactors, excavation and embankment (see also Rollers and rolling): PAGE
Pneumatic tired....111, 112
Sheepsfoot....110, 111
Vibratory....112
Completion of work:
Failure to complete on time....69
Termination of contractor's liability....71
Compliance, certificate of....45
Concrete:
Cutoff walls, slope paving....433–435
Deposited under water....292, 293
End posts, paint for....656
Handling and placing....290–292
Making properties:
Lightweight concrete....329, 330
Portland cement concrete....263, 264
Members, prestressed (see Prestressed concrete members)
Mixers....272–275
Mixing....244, 272–275, 290
On-site mixed....273
Pavements:
Portland cement (see Pavements, Portland cement concrete)
Removal of....98
Piles:
Cast-in-place....378, 383-388
Precast....377–379, 383
Portland cement (see Portland cement concrete)
Prestressed (see Prestressed concrete members)
Properties and tests....235–237
Ready-mixed....273–275
Reinforcement....289
Materials....651–654
Removal and disposal of....99, 100
Concrete curbs, gutters, sidewalks, and ramps....439–443
Concrete curing materials and admixtures....607–609
Admixtures other than air-entraining....607
Air-entraining admixtures....607
Hydrated lime....607
Water for....687
Concrete slope paving and aprons:
Construction methods....433, 434
Cutoff walls....433, 434
Description....433
Earthwork....433
Expansion joints....434
Materials....433
Measurement....435
Payment....435
Concrete structures:
Aprons (see Concrete slope paving and aprons)
Barrier rail....307–309
Bearing devices....297, 298
Bonded grout finish....305, 306
Catch basins (see Catch basins, manholes and inlets)

Concrete structures—*continued* PAGE
Class 1 surface finish....305, 306
Cofferdams and cribs....289
Compaction by mechanical vibration....290, 291
Concrete deposited under water....292, 293
Construction joints....293, 294
Construction methods....281–310
Culverts (see also Culverts)....291, 292, 309, 310
Curbs, gutters, sidewalks, and ramps (see also Curbs, gutters and sidewalks)....439–443
Curing....299
Dead loads....307
Depth of footings....281
Description....281
Elastomeric bearing pads....298
Expansion and fixed joints and bearings....296–299
Exposed aggregate finish....306, 307
Falsework....282, 285–289
Removal of....294–296
Filled joints....296
Fine surfaces....305, 306
Finishing....301–307, 705
Formed surfaces requiring finishing....304–307
Forms....281–285
Corrugated metal....283–285
Plywood....283
Removal of....294–296
Vicinity of railroads, forms in....282
Girders, slabs and columns....292
Handling and placing concrete....290–292
Horizontal surfaces, finish of....301–304
Joints....293, 294, 296–299
Lightweight concrete (see Lightweight concrete for structures)
Live loads....307
Load restrictions....307
Materials....281
Measurement....310–313
Mixing concrete....290
Monuments (see Monuments)
Open joints....296
Ordinary surface finish....304, 305
Patching....299–301
Payment....313, 314
Piles....383–388
Placing concrete....290–293
Culverts....291, 292
Girders, slabs and columns....292
Precast concrete box culverts....309, 310
Pumping concrete....292
Pumping water....290
Reinforcement....289
Removal of falsework, forms and housing....294–296
Repair of concrete bridge deck....300, 301
Slope paving (see Concrete slope paving and aprons)
Steel joints....296

Concrete structures—*continued* PAGE
- Tremie or concrete pump ... 292, 293
- Vibrators, provisions for ... 290, 291
- Waterstops ... 297

Concrete surface, existing (see Existing surfaces)
Concrete surface finishing material ... 705
Concrete tests, properties and ... 235–237
Concrete use items, paint for ... 656
Conditional bids (see also Bids) ... 13
Conditions of employment, wages and ... 89
Conduit:
- Irrigation systems ... 158, 159
- Perforated metal pipe for ... 643

Conference, preconstruction ... 67
Connection angles, steel structures ... 353
Connectors, timber structures ... 369, 370, 374
Construction:
- Joints, cement treated base ... 177
- Joints, concrete structures ... 177, 293, 294
- Load and speed restrictions ... 28
- Maintenance during ... 28
- Signs (see also Signs, construction) ... 85, 551–554
- Stakes, lines and subgrades ... 26

Contact joints, Portland cement concrete pavement ... 247, 248
Contract:
- Alterations ... 17, 18
- Assignment of ... 63, 64
- Award and execution of ... 15, 16
- Bond ... 3, 16
- Completion ... 58, 59
- Contents ... 3
- Default and termination of ... 69–71
- Defined ... 2
- Examination of documents ... 10, 11
- Execution and approval of ... 16
- Failure to execute ... 16
- Increased or decreased quantities ... 17, 18, 29
- Intent of ... 17
- Item, defined ... 3, 5
- Modification ... 24, 29–31
- Separate contracts within limits of one project ... 26
- "Specialty items" ... 63
- Subletting of ... 63, 64
- Termination of ... 69–71
- Time:
  - Commencement of ... 64, 68
  - Completion of ... 68
  - Defined ... 3
  - Determination and extension of ... 67–69
  - Failure to complete work on ... 69

Contractor:
- Bid (see Bidders; Bids)
- Change in operations ... 19

Contractor—*continued* PAGE
Conformity with plans and specifications 24
Cooperation by 24, 25
Between contractors 26
During inspections 27
With utilities 25
Default and termination of contract 69–71
Defined 3
Delays in completion of work (see Delays in completion of work)
Equipment 66
Error or omission in plans or specifications 24
Failure to execute work 23, 69–71
Failure to notify Engineer of change in character of work 18
Fair Labor Standards Act, observation of 50
Federal-aid projects, qualifications 9
Financial ability and experience, statement of 9
Legal rights, no waiver of 61
Licensing 49
Limitation of operations 64, 65
Methods 66
Notice 5, 9
Notice to proceed 64
Defined 5
Payments to 78, 79
Acceptance and final 86, 87
"Extra and force account" 79–81
Partial 82–86
Payroll and statement of compliance, submission 49
Permits, licenses and taxes 49
Plans and working drawings of 23
Prequalification of 9
Prosecution and progress of contract 63–72
Public liability and property damage insurance 53, 54
Railroad's insurance 53, 54
Relations with railroads 51–53
Relief from maintenance and responsibility 58, 59, 70
Responsibility for (see also Legal relations and responsibility):
Archeological and paleontological objects, protection of 56
Artifacts, preservation of 56
Bituminous materials, quality of 611
Claims against subcontractor 55, 63
Claims for materials, supplies, and labor 55
Defective work 56
Explosives, use of 54, 55
Hauling equipment, damage caused by 28
Landscape, protection and restoration of 55–57
Maintenance during construction 28
Materials, supplies and labor 55, 59
Mechanically stabilized earth wall 585
Public convenience and safety 50, 51
Sanitary, health, and safety conditions 50
State furnished materials 47
Supplies 55

Contractor—*continued*
Responsibility for—*continued* PAGE
Surfaces opened by permit....49, 50
Suspension of work....67
Termination of....71
Utility properties, protection and restoration of....49, 50, 55–57, 59, 60
Work and materials....55, 59
Supplemental agreement....7, 17, 18
Value engineering proposals....29–31
Working drawings....8, 23
Workmen's compensation....55
Control of material....33–47
Tubing, irrigation systems....154
Installation of....160
Valves....155, 157
Of work....23–31
Conversion tables from gallons to weight....76
Conveyor scales....74–75
Coordination of plans, specifications, supplemental specifications, and special provisions....24
Copyright....49
Corner posts....455
Covers, catch basins, manholes and inlets....426, 427
Coyote holes, use in blasting prohibited....102
Cribs, concrete structures....289
Structure excavation....121
Culvert, defined....3
Culvert pipes (see Culverts)
Culverts:
Aluminum corrugated metal pipe and aluminum arch:
Construction methods....409
Description....409
Materials....409
Measurement....409
Payment....409
Quality requirements....643
Underdrains....417
Backfill....127
Bituminous fiber pipe for....641
Box culverts, precast concrete....309, 310
Clay pipe for....641
Closing of....98, 99
Concrete and clay pipe and drains for....641
Concrete structures....309, 310
Corrugated metal pipe and metal arch pipe:
Construction methods....406, 407
Description....405
Downdrains....643
Elliptical pipe....406
Laying culvert pipe....406
Materials....405, 406
Measurement....407, 408
Payment....408

Culverts—*continued*
Corrugated metal pipe and metal arch pipe—*continued* PAGE
Relay culvert pipes 407
Siphons 406, 407
Slotted drains 407
Strutting 406
Underdrains 644
Corrugated polyethylene pipe 391, 392, 417–419, 421–423
Extensions of existing culverts 395
Removal of 98
Structural plate pipe and pipe arch culverts 414, 415
Laying culvert pipes 395
Corrugated metal pipe and metal arch pipe 406
Reinforced concrete 400–402
Non-reinforced concrete pipe for (see also Pipe) 397, 398
Perforated bituminous fiber pipe for 641
Perforated metal pipe for 643
Pipe culverts—type of material optional 391, 392
Pipe culverts—general:
Construction methods 394, 395
Description 393
Earthwork 394
End sections 394
End walls 394
Extension of existing culverts 395
General requirements 393–396
Headwalls 394
Inspection of materials 393
Jacked pipes 394
Laying pipe 395
Materials 393
Measurement 395, 396
Payment 396
Water encountered on site 396
Placing concrete in 281, 291, 292
Precast concrete box culverts 309, 310
Reinforced concrete pipe for (see also Pipe) 399–403, 641
Relay culvert pipes 99, 407
Removal of culverts 97–99
Slotted drains 407
Structural plate pipe and pipe arch culverts:
Assembly 413
Bolts 412
Construction methods 412–415
Description 411
Earthwork 413
Extension of existing 414, 415
Field inspection 412, 413
Headwalls 414
Materials 411, 412
Measurement 415
Payment 415
Plates 411, 412

Culverts—*continued*
Structural plate pipe and pipe arch culverts—*continued* PAGE
Quality requirements 644
Salvaged, reinstallation of 411
Strutting 414
Water encountered at site 415
Workmanship 414
Curbs, gutters and sidewalks:
Construction methods 439–442
Curb and gutter construction 440, 441
Curb and gutter joints 440
Description 439
Earthwork 439
Existing concrete, removal 439
Forms 440
Materials 439
Measurement 442
Payment 442, 443
Removal of 98
Sidewalk construction 441, 442
Sidewalk expansion joints 440
Curing:
Cement concrete, water for 687
Cement treated base 177, 178
Concrete bridge deck repair 301
Concrete deposited under water 293
Formed concrete 299
Liquid asphalt materials 615–619
Materials and admixtures, concrete 607–609
Roadbed modification 183
Curing Portland cement concrete 275–278
Compound method 276–278
Form method 278
Pavement 253, 254
Under water 293
Water method 276
Waterproof membrane method 278
Curing prestressed concrete members 323
Cuts, widening 103
Measurement and payment for 114

D

Damage claims, contractor's responsibility for 55
Dampproofing 591; 592, 611
Day, calendar, defined 2
Day, work, defined 8
Decreased quantities, increased or 17, 18, 29–31
Default and termination of contract 69–71
Defective materials, contractor's responsibility for 59
Defective work, contractor's responsibility for 59
Definitions and terms 1–8

PAGE
Delays in completion of work 69
Adjustment of contract time 68
Due to cooperation with utilities 25
Due to preservation of artifacts and archeological and paleontological objects 56
Due to restoration of surfaces opened by permit 49, 50
Right of way 71
Department, defined 3
Department furnished material 47
Department of Transportation, testing methods 45, 46
Determination and extension of contract time 67–69, 71
Detour, defined 3
Detours 545, 548, 549
Detours, arrangements for 19, 20, 64, 552
Dewatering, structure excavation 121
Directors, defined 4
Dirt embankment, compaction of 109, 110
Disposal of materials (see also Removal of structures and obstructions):
Burning prohibited 92
Clearing and grubbing 92, 93
Excavated 99, 100
Non-perishable 97
Outside highway right of way 57, 58, 65, 92, 97, 100, 102, 149
Structure excavation materials 122
Visual analysis and erosion control studies of proposed site 58
Disqualification of bidders 12, 13
Distribution plates or assemblies, anchorage and 318, 319
Testing prestressing anchorages 653
Distributors for bituminous roadmix surface 215, 216
Ditch and channel excavation 101, 105
Overhaul on 119, 120
Ditch and dike areas, roads in 56, 57
Divided highway, defined 4
Downdrains 421–423
Anchor assembly 421, 422
Construction methods 421, 422
Corrugated metal pipes for 421, 643
Description 421
Embankment protectors 421, 422
Materials 421
Measurement 422
Payment 422, 423
Riprap 421
Drain backfill:
Aggregates for 624
Construction methods 131
Measurement 131
Payment 131, 132
Underdrains, around 131, 417
Drain valves, irrigation systems 156
Drainage:
Downdrains 421–423
Excavation 101

Drainage—*continued* PAGE
Roadway construction, drainage during ... 105
Structures, perforated metal pipe for ... 643
Structures, removal of ... 97, 98
Drains, concrete and clay pipe for ... 641
Metal pipe for ... 643, 644
Drains, slotted corrugated metal pipe ... 407
Drawings, working (see Working drawings)
Drilling, steel structures ... 349, 350, 352
Driving of piles ... 379
Equipment ... 378–380
Ducts for prestressing steel ... 319, 320
Dust, control by watering ... 133, 134
Control ... 61
Dust palliative (see also Pollution control) ... 579

E

Earth wall, mechanically stabilized ... 584–589
Earthwork:
Bin-type retaining walls ... 437, 438
Catch basins, manholes and inlets ... 427
Cattle guards ... 459
Concrete curbs, gutters, sidewalks, and ramps ... 439
Concrete slope paving ... 433
Pipe culverts—general ... 394
Reinforced concrete pipe ... 400
Riprap ... 430
Structural plate pipe ... 413
Underdrains ... 418
Edge planing, steel plates ... 353
Elastomeric bearing pads ... 298, 365
Certificate of inspection ... 695
Material requirements ... 695–698
Physical properties and tests ... 695–698
Elastomeric joint seal, preformed ... 298, 299
Electronic Industries Association ... 1, 471
Eliminated items from contract ... 70, 81
Elliptical:
Concrete pipe, reinforced ... 402
Corrugated metal pipe ... 406
Embankment (see also Earthwork):
Construction with excavated materials ... 99, 100
Dirt, compaction of ... 109, 110
Excavation and (see also Excavation and embankment) ... 101–116
Foundation areas ... 106, 107
Watering ... 133, 134
Maintenance ... 112, 113
Material ... 107
Pipe installation in new ... 400
Placing ... 107–109
Protectors; downdrains ... 421, 422
Rock, compaction of ... 110–112

Embankment—*continued* PAGE
Structures against 107
Water for wetting of 687
Employee, defined (see also Workmen) 4
Employment, wages and conditions of 89
Emulsions, asphaltic 619–622
Anionic specifications table 621
Average weights and volumes table 76
Cationic specifications table 620
Enclosures for prestressing steel 319, 320
End:
Connection angles, steel structures 353
Corner and gate posts 455
Posts, concrete, paint for 656
Sections, pipe culverts 394
Engineer:
Authority of 23, 27, 31, 69–71
Decisions of 23
Defined 4
Inspection by 27–29
Resident, authority and duties of 26
Engineering fabrics 721
Engineering proposal, value 29–31
Epoxy:
Bonding new concrete to old and fastening horizontal metal anchors 708, 709
Certificates 707
Concrete and mortar and fastening vertical metal anchors 708
Directions for use 708
Packaging, labeling, and storing 707, 708
Rapid set for bonding pavement markers to concrete or asphalt 709
Sampling and testing 707
Scope 707
Sealing inductive wire loops and leads in concrete or asphalt 709–711
Standard set for bonding pavement markers to concrete or asphalt 709
Types of epoxies 708–711
Equipment (see also Compactors; Rollers; Truck mixers; Vibrators):
Concrete structure construction 290, 291
Defined 4
"Equipment hours" 19
Excavation and embankment 110–112
Idle time 71
Parking 65
Pile driving 378–380
Portland cement concrete construction 240–243, 266, 361–364
Rental 76, 77, 80, 81, 547
Requirements 66
Steel structure construction 364, 365
Substitute equipment 66
Erection methods, steel structures 364, 365
Erosion control (see also Roadside materials):
Compaction of topsoil 136–137
Construction methods 136–139
Contractor's responsibility 57

Erosion control—*continued* PAGE
Cultivation 136
Description 135
Fabric, erosion control 138, 139, 701
Fertilizer 135
Local material sites, requirements 34–36
Materials 135, 136, 699–703
Measurement 139
Mulch 135, 136, 138
Payment 139, 140
Seed 135
Seeding and fertilizing 137, 138
Topsoil 135–137
Visual analysis and erosion control studies of proposed site 36, 58
Excavation, adjacent to trees 158
Excavation and backfilling of removed structures 97
Excavation and embankment:
Blasting 102
Borrow 101, 102, 105, 106
Channel excavation 101, 105
Compaction:
Construction methods 109–112
Dirt embankment 109, 110
Equipment 110–112
Rock embankment 110–112
Testing by construction methods and equipment 109–112
Construction methods 102–113
Description 101
Drainage during construction of roadway 105
Drainage excavation materials 101
Foundations for 106, 107
Maintenance 112, 113
Materials 101, 102, 107
Measurement 73, 113–115
Overbreak 103
Payment 115, 116
Placing embankment 107–109
Roadway excavation 101, 102
Rock cuts 102, 103
Rock materials 108
Selected material 104
Slides and slipouts 104
Slopes 103
Surplus material 103, 104
Unsuitable material 99, 102
Removal of 102
Widening cuts 103
Excavation, structure 121–123
Execution of contract, award and 15, 16
Existing surface:
Preparation 198, 216, 223, 224
Roadbed modification 181–184
Recycled plantmix bituminous surface 208, 209

PAGE
Expansion and fixed joints and bearings....296–299
Experience statement of bidder....9
Explosives, use of (see also Blasting)....54, 55
Extension:
Of contract time....56, 67–69, 71
Of existing culverts and bridges....98
Of existing culverts, structural plate pipe and pipe arch....414, 415
Extra and force account work....79–81
Idle time of equipment....71
Right-of-way delays....71
Special equipment....77
"Extra work"....18
Defined....4

F

Fabric, erosion control....138, 139, 701
Fabric, pavement reinforcing....189, 202, 203, 721
Fabricated steel bar reinforcement....651
Fabrics, engineering....721
Facilities, utility (see Utility property and services)
Facing of bearing surfaces, steel structures....353
Failure:
To carry on work in acceptable manner....69–71
To complete work on time....69
To execute contract....16
To execute work....23
To maintain roadway or structure....28
Fair Labor Standards Act....50
Falsework, concrete structures....282, 285–289
Removal of....294–296
Falsework lighting....538–540
Falsework, steel structures....365
Fastenings (hardware), galvanizing of....657
Federal agencies, approval of work....50
Federal aid projects:
Bidder's requirements....9
Inspection by Federal agencies....50
Federal Highway Administration—Department of Transportation....1
Federal land, source of material located on....35–39
Federal Specifications and Standards, General Services Administration....1
Fence materials....691–694
Fences:
Partial payments on....85, 86
Removal and disposal of....65, 93, 97–100
Fencing (see also Fence materials):
Barbed wire and farm....455
Chain link....453, 455, 456
Construction methods....453–457
Corners....454
Description....453
Existing connections with new....453, 454

Fencing—*continued* PAGE
Gates....456, 457
Line posts....455
Materials....453
Measurement....457
Metal posts....455
Partial payments on....85, 86
Payment....457
Posts....453–456
Quality requirements....691–694
Reconstructed....456
Standard....454, 455
Temporary fencing, providing....65
Wire, barbed and woven....455
Fertilizers and additives, landscaping....149
Commercial....135, 699, 700
Fertilizing, seeding and....137, 138
Field assembly, steel structures....366
Field inspection, structural plate pipe....412, 413
Field painting, steel structures....366
Filled joints, concrete structures....296
Fillers, commercial mineral....630
Fillers, joint....637
Final acceptance....28, 29
Cleanup....20, 21, 68, 69
Inspection....28, 29
Payment....86, 87
Financial statement of bidders....9
Fine aggregates:
For grout and mortar sand....635, 636
Portland cement concrete....261, 262
Portland cement products....634, 635
Finished surface, Portland cement treated base....177
Finishing:
Bearing and base plates....353
Concrete structures....301–307
Bonded grout surface....305, 306
Class 1 surface finish....305, 306
Exposed aggregate....306, 307
Fine surface....305, 306
Formed surface....304–307
Horizontal surface....301–304
Ordinary surface....304, 305
Concrete surface finishing material....705
Plantmix bituminous base....169
Plantmix bituminous pavements—general....200, 201
Plantmix bituminous surface....207
Pneumatically placed concrete mortar....603
Portland cement concrete pavements....251, 252
Roadbed modification....183
Roadmix bituminous surface....219
Fire:
Hydrants....60
Prevention and control, forest protection....57

PAGE
Fittings, guardrail materials....683, 684
Fixed joints and bearings, expansion and; concrete structures....296–299
Flaggers....545, 546
Flagging protection, railroad....52
Flame cutting, steel or wrought iron....353
Flushing and testing, irrigation systems....160, 161
Footings, depth of; concrete structures....281
"Force account work" (see also Extra and force account work):
Claims for adjustment and disputes....29
Default of contract....70
For "special detours" or "maintain base"....19
Payment....79–81
Work in dispute....18
Forest protection....57
Forfeiture of proposal guaranty....16
Forged steel products, galvanizing of....657
Form clamps or bolts, concrete structures....283
Formed concrete, curing of, concrete structures....299
Forms:
Concrete structures....281–285
Corrugated metal....283–285
Curbs and gutters....440
Portland cement concrete pavement....242, 243
Prestressed concrete members....318
Removal of....294–296
Railroads, over or in vicinity of....282
Setting....243, 244
Foundation, embankment....106, 107
Foundation Fill:
Compaction of....129
Construction methods....129
Description....129
Measurement....129
Payment....129, 130
Foundations, removal and disposal of....93, 97
Frames and grates, painting of....449
Free haul distance....119
Frontage road or frontage street, defined....4
Fuel tax, refund of....13

G

Gage, meaning of....73
Galvanized guardrail....462, 463
Galvanizing:
Hardware....657, 689
Line posts....693
Materials....657
Mechanical galvanizing....657
Products 1/8" and thicker....689
Rail elements....657
Gaskets....637

	PAGE
Gates:	
Drive	694
Fencing	456, 457, 694
Metal	694
Posts	455
Temporary gates, providing	65
Walk	694
Wire mesh	694
Girders, slabs and columns:	
Concrete structures	292
Precast prestressed concrete	315–328
"Glue down" curbs	439–443
Gradation requirements, Portland cement concrete aggregates	261, 262, 631–636
Grade separation, defined	51
Grades and lines, construction stakes	26
Grading operations:	
Roadway	101, 102
Watering of for dust control	133, 134
Grading requirements tables, base aggregates	624–626
Granular backfill	125
Grates, frames and, painting of	449
Gravel (see Aggregates)	
Gray iron castings	649
Grid rollers	111
Grout:	
Aggregate, requirements for	635, 636
Finish, concrete structures	305, 306, 705
Grouted riprap	429–432
Grubbing, clearing and (see also Clearing and grubbing)	91–95
Guardrail	461–464
Construction methods	462, 463
Description	461
Galvanized	462, 463
Material requirements	683, 684
Materials	461, 462
Measurement	463
Partial payments on	85, 86
Payment	463, 464
Posts	461, 462
Reconstructed	463
Reflectors	462
Removal and disposal of	97
For reuse	99
Guardrail materials	683, 684
Paint for	655
Timber posts for	679
Guide posts (see also Object markers and guide posts)	465, 466, 685, 686
Guide signs (see Signs)	
Gutter construction, curb and (see also Curbs, gutters and sidewalks)	439–443
Guying, staking and, landscaping	147

H

PAGE
Handling materials 46
Hardware:
Bolts, nuts, dowels and drift bolts 689
Galvanizing of 657, 689
Materials covered 689
Steel structures 350–352
Timber structures 371
Washers 689
Hauling equipment:
Compliance with laws and regulations 65
Bituminous mixtures 196
Contractor's responsibility for damage caused by 28
Hay or straw mulch materials 700, 701
Headwalls:
Pipe culvert 394
Placing concrete in 281
Structural plate pipe 414
Health, safety, and sanitary provisions 50
Heavy riprap 429–432
High strength steel 645
High tensile strength:
Bolts 645
Steel bars 651–654
Wire strand 651–654
Highway:
Defined 4
Divided highway, defined 4
Opened by permit, restoration of 49, 50
Signs (see Signs)
Historic and archeological studies 36
Holes:
For bolts, dowels, rods and lag screws; timber structures 371
Piles 384
Pin holes 363
Subpunching, drilling, and reaming 349, 350
Holidays:
Defined 4
Limitation of operations on 64, 65
Hose bibs, irrigation systems 156
Housing, removal of; concrete structures 294–296
Humus 699, 700
Hydrated lime 607

I

Illumination Engineering Society 471
Increased or decreased quantities and change in character of work 17, 18, 29–31
Injury:
To persons, compensation for 55
To work, contractor's responsibility for 59, 71
Inlets, catch basins, manholes and; removal of 98

	PAGE
Inspection:	
By Chief Engineer (railroad)	51
By Engineer	27
By Federal agencies	50
Drilled shaft inspection report	384, 385
Erosion control materials	135
Final	28, 29
Of materials	26, 27, 46
Of plant material, landscaping	142, 143
Pipe culverts	393
Plant	46
Stored materials	46
Structural plate pipe	412, 413
Structural steel	347, 348
Timber	452
Timber piles and piling	382
Welds	355–358
Work	26–29, 46
By utility corporations	27
Inspector, authority and duties of	26
Defined	5
Installation:	
Irrigation systems	158–160
Of permanent signs	560, 561
Institute of Electrical and Electronics Engineers	1
Insurance, liability	53, 54
International Municipal Signal Association	471
Interpretation of plans and specifications by Engineer	23, 24
Iron:	
Gray iron castings	649
And steel use items, paint for	655
Irregularities, proposal	11, 12
Irrigation systems:	
Adjusting	161
Air relief valve	157
Automatic controllers	154
Backfill	161
Backflow preventers	156, 159
Bedding and backfilling	153
Conduits	158, 159
Construction methods	157–161
Control tubing	154
Installation of	160
Control valves	155
Description	153
Drain valves	156
Excavation for	157
Adjacent to trees	158
Existing facilities, installation of pipe to provide minimum stoppage of water	65
Flushing and testing	160, 161
Gate valves	155
Hose bibs	156
Installation	158–160

Irrigation systems—*continued* PAGE
Jointing ... 158
Materials ... 699
Measurement ... 161
Partial payments on pipe ... 86
Payment ... 161, 162
Piping ... 158
Quick coupler valves ... 155, 156
Sprinkler connections ... 159
Sprinkler heads ... 154
Testing, flushing and ... 160, 161
Timber for minor irrigation structures ... 452
Vacuum breakers ... 156, 157
Valve boxes ... 156
Valve protection sleeves ... 154
Watering ... 147, 148

J

Jacked pipes; pipe culverts ... 394
Joint material ... 637–639
Jointing, irrigation systems ... 158
Joints:
Concrete structures ... 293, 294, 296–299
Corrugated metal pipe ... 407
Curbs and gutters ... 440
Mortar ... 400–402
Plantmix bituminous open-graded surface ... 212
Plantmix bituminous pavements ... 202
Portland cement concrete pavement ... 247–251
Portland cement treated base ... 177
Precast concrete box culverts ... 310
Preformed elastomeric joint seal ... 298, 299
Reinforced concrete pipe ... 400–402
Rubber gasketed ... 402
Sealer ... 638, 639
Steel structures ... 353

L

Labor (see also Workmen):
Bond requirement ... 16
Claims, responsibility for ... 55
Fair Labor Standards Act ... 50
Laboratory, defined ... 5
Lacing bars, steel structures ... 353
Landscape, protection and restoration of ... 55–57
Landscaping (see also Roadside materials):
Construction methods ... 143–149
Description ... 141
Existing facilities, protection of ... 149
Fertilizers and additives ... 149

Landscaping—*continued* PAGE
Handling and shipping of materials 142
Inspection of plant material 142, 143
Lumber 143
Materials 141–143
Measurement 149, 150
Mulch, use of 146
Nomenclature 141
Payment 150, 151
Plant establishment work 149
Plant materials, quality of 141, 142, 699, 701
Planter boxes 144
Planting:
Areas, preparation of 144, 145
Beds 144
Holes 144
Layout of 143, 144
Method 145, 146
Trenches 145
Pruning 147
Replacements of plants 148
Staking and guying 147
Storage, temporary 143
Substitution of plants 143
Water for 687
Watering 147, 148
Laws to be observed 49
On wages and conditions of employment 89
Laying pipes:
Corrugated metal and metal arch 406
Culvert 395, 400–402, 406
Reinforced concrete 400–402
Underdrains 418
Legal relations and responsibility 49–61
Disposal of material outside highway right of way 57, 58
Explosives, use of 54, 55
Fair Labor Standards Act 50
Forest protection 57
Laws to be observed 49
Legal rights, no waiver of 61
Liability for subcontractor 55, 63, 64
Liability insurance 53, 54
Local materials located on private land 40
Materials, supplies and labor 55, 59
Patents or copyright 49
Permits, licenses and taxes 49
Personal liability of public officials 55, 61
Property and landscape, protection and restoration of 55–57
Public convenience and safety 50, 51
Railroads, relations with 51–53
Relief from maintenance and responsibility 58, 59
Responsibility for work and materials, contractor's 59
Restoration of surfaces opened by permit 49, 50

Legal relations and responsibility—*continued* PAGE
Sanitary, health and safety provisions 50
Termination of contractor's responsibility 71
Utility properties 49, 50, 55, 56, 59, 60
Workmen's Compensation Act 55
Length of bridge structure, defined 2
Liability insurance 53, 54
Licenses, permits and taxes 49
Light or medium riprap 429–432
Lightweight, aggregates 633, 634
Lightweight concrete for structures:
Admixtures 329
Aggregates, storage of 330
Classification and proportions 330–332
Concrete making properties 329, 330
Construction methods 330–332
Description 329
Materials 329, 330
Measurement 332–334
Mixing 332
Payment 334
Requirements and test methods for 329, 330
Limitation of operations 64, 65
Line posts 455, 691–693
Certificates 691
Paint for 693
Lines and grades, construction stakes 26
Liquid asphalts:
Average weights and volumes table 76
Curing products tables 616–618
Demerit schedule 619
Temperature table 226
Live loads, concrete structures 307
Load:
And speed restrictions 28
Restrictions on concrete structures 307
Testing, piling 381, 382
Local materials:
Antiquities and objects of historical value 39
Archeological and historic studies of proposed site on private land 36
Arrangements with property owners 34, 35, 39, 40
Contractor-furnished sources 41
Defined 33
Department-furnished sources 41, 42
Found in vicinity of work 33–42
On work 20
Hauling over local, public, or private roads or property 35
Investigation by bidder or contractor 40
Owned by U.S. Government 36–40, 42
Partial payments on 83, 84
Pit operations, requirements 34
Possible sources 35–42
Protection of surface natural resources and improvements 39

Local materials—*continued* PAGE
Samples and tests....43–46
Sites, requirements....33, 34, 36
Visual analysis and erosion control studies.... 36
"Loose measurement".... 75
"Low alkali cement".... 605
Lumber:
For landscaping.... 143
Preservative treatments for....451, 452
Quality requirements for.... 679

M

"Maintain base".... 546
Maintenance:
During construction.... 28
Embankment material....112, 113
Relief from....58, 59
Of traffic (see also Accommodations for public traffic):
During construction....18–20
During removal of structures.... 97
During surface treatment....231, 232
During suspension of work....19, 67
Roadway or structure, failure to maintain.... 28
Major contract item, defined.... 5
Malleable castings.... 649
Manholes, inlets, catch basins and....425–428
Removal of.... 98
Manual on Uniform Traffic Control Devices For Streets and Highways.... 2
Manufacturers' warranties or guaranties.... 33
Marker posts, metal....467, 470
Markers:
Culvert (see also Object markers and guide posts)....465, 466, 685, 686
Metal posts....467, 470
Monument (see also Monuments)....469, 470
Right of way (see also Right of way markers)....467, 655
Timber, quality requirements.... 679
Marking and shipping, structural steel members.... 364
Marking film, pavement....571, 723, 724
Masonry:
Blocks, roadside materials.... 703
Removal and disposal of....99, 100
Retaining wall....583, 584
Stone for.... 636
Materials:
Accompanied by certificate of compliance.... 45
Bond requirement.... 16
Claims, responsibility for.... 55
Contractor's responsibility for.... 59
Control of....33–47
Damaged.... 59
Defective materials, rejection....26, 27

Materials—*continued* PAGE
Defined 5
Delay in furnishing critical materials 68
Department furnished 47
Details 605–724
Excavated 99, 100, 103, 104
Found on work (see Local materials)
Guaranty by bidder 13
Handling of 46
Inspections:
Engineer, authority 27
Inspector, authority 26
Plant 46
Records of 33
Local (see Local materials)
Measurement of (see various sections covering items of work)
Non-perishable, disposal of 97
Outside highway right of way, disposal of 57, 58
Refusal to permit use 45
Rejected material 46, 47
Removing and replacing 27
Rights in and use of materials found on the work 20
Roadside production of 63
Salvage of excavated 99
Samples and tests 43–46
Storage of 46, 51, 52, 59
Surplus, excavated 103, 104
Unacceptable 46, 47
Unusable, perishable, disposal of 97
"Measured in the vehicle" 75
Measurement and payment (see also sections for various items of work) 73–87
Bituminous tables, weights and volumes 76
Common carrier rate adjustments 81, 82
Eliminated items 81
Extra and force account work 79–81
Partial payment 82–86
Quantities, measurement of 73–78
Scope of payment 78, 79
Mechanical galvanizing 657
Median, defined 5
Mesh, wire, fence materials 693
Metal bin-type retaining walls (see also Retaining walls, metal bin-type) 437, 438
Metal, miscellaneous 649
Metal pipe and drains 643, 644
Physical properties and tests 643, 644
Scope 643
Metal posts (see also Posts):
And braces 692, 693
For chain link fence 455, 456
For fence materials 692, 693
For object markers and guide posts 685
Guardrails 461, 462
Marker 467, 470
Tubular 692

PAGE

Methods and equipment (see also Equipment) 65, 66
Substitute 66
Military specifications 1
Mineral aggregates:
Base and surfacing materials, watering 133, 134
Base courses 623–626
Bituminous courses 627–630
Portland cement products 631–636
Mineral filler, commercial 630
Miscellaneous:
Concrete items, paint for 656
Iron, paint for 655
Metals 649
Timber structures, paint for 655
Misfits, steel structures 366
Mixing methods for:
Bituminous mixtures 189–196, 200, 217, 218
Concrete 244
Concrete structures 290
Lightweight concrete 332
Roadbed modification 182, 183
Mobilization:
Description 565
Lightweight concrete 332
Partial payments on 86
Payment 565
Plantmix bituminous pavement 200
Portland cement treated base 171–174
Plantmix 173, 174
Roadmix 171–173
Roadbed modification 182, 183
Modification, roadbed (see also Roadbed modification) 181–184
Monuments 469, 470
Protection of by contractor 55, 56
Mortar:
Aggregate requirements for 635, 636
Bands of, for non-reinforced concrete and clay pipe 397, 398
Concrete mortar, pneumatically placed 601–603, 635, 636
Joint, for reinforced concrete pipe 399
"Low alkali" or "blended" cement used in 605
Masonry retaining wall 583, 584
Patching concrete structures 299–301
Motor fuel tax refund 13
Motor graders, for roadmix bituminous surface 215
Mulch:
Application of tackifier 138
Blowers 146
Erosion control 135, 136, 138
Hay or straw 700, 701
Humus 146
Landscaping 146
Quality requirements 700, 701

Mulch—*continued* PAGE
Spreading 138
Tackifier used as tie-down for 136, 138
Wood cellulose fiber 701
Wood chips and shavings 701

N

Nails, fence materials 694
National Electric Code 1, 471
National Electrical Manufacturers Association 2, 471
Neoprene, for elastomeric bearing pads 695–698
Nomenclature for plant names; landscaping 141
Non-perishable material, disposal of 97
Notices:
Award of contract 15
Claims for additional compensation 29
Delay, neglect, or default 70
Discontinuance of work, resuming operations 64
Explosives, use of 55
Failure of contractor to execute work 23
Failure of contractor to restore property or repair damage 56
Final acceptance, date of 29
Railroad, beginning work in proximity of 51
Saturdays, Sundays, and holidays, intention to work 64
Steel mills, beginning work 347
To contractors 9
Defined 5
To proceed 64
Defined 5
Utilities, property that may be affected by work 60
Nuisance, dust 61
Nuts:
For signs 673
For steel structures 346
Galvanizing of 657

O

Object markers and guide posts 465, 466
Certificates 685
Construction methods 465
Description 465
Measurement 465
Payment 465, 466
Reflectors 686
Removal and disposal of 97
For reuse 99
Reset 465
Target members 465
Target plates 685, 686
Obstructions (see also Removal of structures and obstructions) 97–100
Occupational safety and health administration 2

PAGE
On-site mixed concrete 273
One-way traffic 18
Open joints, concrete structures 296
Opening of proposals, public 12
Openings in the highway, restoration of 49, 50
Operations (see Work)
Order of preference, plans and specifications 24
Overbreak, excavation and embankment 103
  Measurement and payment for 113, 114
Overhaul:
  Description 119
  Measurement 114, 119
  Payment 119, 120
Overhead structures, protection of 55, 56

P

Pads, elastomeric bearing 298
Paint materials (see also Galvanizing):
  Bridge railings 655
  Cattle guard wings 655
  Certificates for 655
  For concrete end posts 656
  For concrete use items 656
  For guardrail 655
  For iron and steel use items 655
  For line posts 693
  Materials covered 655
  Miscellaneous concrete 656
  Miscellaneous iron 655
  Miscellaneous timber structures 655
  Physical properties and tests 655, 656
  Right of way markers 655
  Sign posts 655
  Standard metal rail 655
  Steel bridge railing 655
  Target plates 686
  Timber use items 655
  Traffic paint 713–718
Painted pavement marking 577, 578
Painting:
  Application, general 446
  Construction methods 445–449
  Description 445
  Field cleaning, structural steel 448
  Frames and grates, structural steel 449
  Machine finished surfaces 449
  Materials 445
  Number of coats 445
  Payment 449
  Prepared paints 445
  Proprietary materials 445

Painting—*continued* PAGE
Raw materials 445
Steel structures 364, 366
Steel surface preparation 446–448
Structural steel 448, 449
Timber 374, 449
Weather conditions 446
Paleontological objects, preservation of 39, 56
Palliative, dust (see also Pollution control) 579
Partial payments:
Concrete 83
Local materials 83, 84
Manufactured materials 83
Miscellaneous 85, 86
Schedule 84
Signs and barricades 85
Structural steel 83
Patching, concrete structures 299–301
Patents 49
Pavement markers:
Construction methods 568–570
Description 567
Materials 567, 568
Measurement 569
Painted pavement marking 577, 578
Payment 569, 570
Temporary pavement striping tape 573–575
Temporary striping 51
Traffic paint 713–718
Pavement marking film 571, 723, 724
Pavement marking, painted 577, 578
Pavement reinforcing fabric 721
Pavement striping tape, temporary 573–575
Pavements, bituminous plantmix:
Aggregates 189, 194, 195, 198–200
Breakdown rollers 197
Commercial mineral filler 189, 200
Composition of mixtures 187, 188
Construction methods 189–203
Description 187
Existing surface, preparation of 198
Finish rollers 198
Finishing, spreading and 200, 201
Hauling equipment 196
Joints 202
Materials 187–189, 198
Measurement 203, 204
Mixing 200
Mixing plants 189–196, 199, 200
Pavement reinforcing fabric 189, 202, 203
Pavers 197
Payment 204, 205
Pneumatic-tired rollers 195, 196

	PAGE
Pavements, bituminous plantmix—*continued*	
Preparation of aggregates	198–200
Rollers	195, 196
Rolling	201, 202
Spreading and finishing	200, 201
Surface tolerances	202
Surfacing miscellaneous areas	202
Weather limitations	198
Pavements, old, removal and disposal of	97, 98
Pavements, Portland cement concrete:	
Admixtures	237
Aggregates, grading limits of combined	238
Batch plant and equipment	240–242
Classification and proportions	237–240
Compaction of	245–247
Compressive strength	237, 258
Concrete saw	242
Construction methods	237–255
Curing	253, 254
Description	235
Equipment	240–243
Finishing	251, 252
Finishing equipment	242
Forms	242, 243
Gradation requirements	235
Grade, preparation of	243
Joints	247–251
Materials	235–237
Measurement	255–258
Mixers	242
Mixing	244
Payment	259, 260
Placing	244, 245
Properties and tests	235–237
Protection of pavement	254, 255
Reinforcement	244
Riding tolerances	252, 253
Setting forms	243, 244
Spreading, compacting and shaping	245–247
Thickness requirements for	256–258
Vibrators	242, 243
Pavers, bituminous	197
Paving asphalts, measurement of	76
Payment (see also Measurement and payment):	
Claims, contractor's guarantee of payment	55
Contract item, defined	3
Extra work (see Extra work)	
Final acceptance and	86, 87
Force account (see Force account work)	
Item shown on plans and not in proposal	10
Measurement and (see also sections for various items of work)	73–87
Partial	82–86
Railroad, work or operations performed by	52

Payment—*continued* PAGE
Schedule of partial payments 84
Scope of 78, 79
Taxes, privilege 49
Value engineering proposals 29
Penetration of piles, bearing value and 380
Pentachlorophenol 451
Permanent concrete barrier rail 307, 308
Permanent pavement marking film 723, 724
Permanent signs (see also Signs, permanent) 559–563, 659–675
Permit, restoration of surfaces opened by 49, 50
Permits, licenses, and taxes 49
Personal liability of public officials 55, 61
Persons, responsibility for injury to, by contractor 55
Piers, placing and compacting at 126
Piles:
Preservative treatments for 451, 452
Prestressed concrete members (see Prestressed concrete members)
Steel 649
Steel shell for 649
Timber 677
Treated 370, 371
Piling:
Bearing value and penetration 380
Cast-in-place concrete 378
Construction methods 377–388
Cutoff and extensions 380, 381
Description 377
Driving of 379
Equipment 378–380
Heads, treatment of 382
Lengths of 377
Load testing 381, 382
Materials 377
Measurement 388, 389
Payment 389, 390
Precast concrete 377–379, 381, 383
Preservative treatment of 451, 452
Steel 388
Test 377, 378
Payment for 389
Timber 382, 383
Timber caps 382
Pilot cars 546
Pilot line 573–575
Pins and rollers 646
Pins, rollers and pin holes 363, 364
Pipe (see also Culverts):
Aluminum alloy for 647
Aluminum corrugated metal pipe and aluminum arch culverts 409
Bituminous coated corrugated metal pipe and pipe arches 643
Bituminous coated corrugated metal pipe for underdrains 644
Bituminous fiber pipe 641

Pipe—*continued* PAGE
Catch basins, manholes and inlets; pipe or tile placed in masonry 426
Clay pipes 641
For underdrains 417
Concrete and clay pipe and drains 641
Corrugated aluminum pipe for underdrains 644
Corrugated metal pipe and metal arch pipe 405–408
Corrugated metal pipe and pipe arches 643
Corrugated polyethylene pipe 391, 392, 417–419, 421–423
Culvert pipes (see also Culverts) 391–396
Installation of pipe:
In new embankment 400
In underdrain outlets 418
Irrigation pipe 153, 158
Metal pipe and drains 643, 644
Non-reinforced concrete and clay pipe 397, 398
Quality requirements 641
Perforated:
Bituminous fiber pipe 641
Concrete pipe 641
Concrete pipe for underdrains 417–419
Metal pipe 643, 644
Polyvinyl chloride (PVC) pipe 153–162
Reinforced concrete pipe 399–403
Quality requirements 641
Sewer (see Sewers)
Structural plate pipe and pipe arch culverts 411–415
Underdrains, pipes for (see also Underdrains) 417–419, 641–644
Welded seamless steel pipes 645
Pipe and pipe fittings:
Irrigation systems 159, 160, 397
Material requirements 702
Pipe brackets, sign materials 673
Pipe lines, abandoned, removal and disposal of 97
Piping 153, 158, 702
Pits:
Backfilling 97
Borrow pits 105, 106
Excavation of local materials, requirements 33–35
Protection of 20, 21
Plans and specifications (see also Specifications):
Alterations 17, 18
Available on work at all times 24
Change in by contractor 19
Conformity with 24
Contents of plans 23
Contract modification 24
Coordination of 24
Definitions 5, 6
Errors or omissions 24
Examination of 10, 11
Intent of 24
Interpretation of 23, 24

Plans and specifications—*continued* PAGE
Order of preference 24
Working drawings (see also Working drawings) 23
Plans, defined 5
Plant inspection 46
Planter boxes, landscaping 144
Planting areas, landscaping 144, 145
Planting trenches 145
Plantmix:
Bituminous base (see also Bituminous plantmix base) 169, 170, 628, 629
Bituminous open-graded surface (see also Bituminous open-graded surface) 211–213, 629, 630
Bituminous pavements (see also Pavements, bituminous plantmix) 187–205
Plants, landscaping (see also Planting areas; Roadside materials):
Classification 141
Establishment work 149
Handling and shipping 142
Inspection of 142, 143
Method of planting 145, 146
Nomenclature for names of 141
Pruning 147
Quality of 141, 142, 699, 701
Replacements 148
Staking and guying 147
Storage, temporary 143
Substitution 143
Water for 687
Watering 147, 148
Plates:
Galvanizing of 657, 672
Steel 353
Stiffener, galvanizing of 673
Platform scales 74
Plywood for forms, concrete structures 283
Pneumatic tired compactors and rollers 111, 112, 197, 198
Pneumatically placed concrete mortar:
Construction methods 602, 603
Description 601
Finishing 603
Materials 601, 602
Measurement 603
Payment 603, 604
Placing 602, 603
Preparation of foundation 602
Pole lines, protection of 55, 56
Pollution control:
Construction methods 579, 580
Description 579
Materials 579
Measurement 581
Payment 581
Polyvinyl chloride (PVC) pipe:
Construction methods 157–161

Polyvinyl chloride (PVC) pipe—*continued* PAGE
Bedding and backfilling 153
Description 153
Installation 159, 160
Measurement 161
Payment 161, 162
Roadside materials 702
Sign posts 675
Portable precast concrete barrier rail 308, 309, 551–554
Portland cement concrete (see also Lightweight concrete for structures):
Admixtures 262, 263
Aggregates:
Grading limits of combined 238
Storage of 268
Cement, protecting and sampling 266, 268
Classifications and proportions 268–270
Concrete making properties 263, 264
Construction methods 266–280
Curing of 275–278
Description 261
Equipment 266, 271–275
Gradation requirements 261, 262
Hand mixing 275
"Low alkali" or "blended" cement used in 605
Machine mixing 272–275
Materials 261–266
Materials details of Portland cement 605
On-site mixed concrete 273
Pavements (see Pavements, Portland cement concrete)
Payment 280
Pozzolan used in 605, 609
Proportioning methods 269–272
Proportions, classifications and 268–270
Protecting and sampling cement 266, 268
Ready-mixed concrete 273–275
Requirements and test methods 261–263, 605
Retempering 275
Riprap, sacked (see also Riprap) 429–432
Statistical evaluation of concrete strength 264–267
Structures (see Concrete structures)
Test methods, requirements and 261–263
Truck mixer or agitator 273–275
Water for 687
Weather limitations 278–280
Portland cement materials details 605
Portland cement products, aggregates for (see also Aggregates, Portland cement products) 631–636
Portland cement treated base 171–180
Post clamps, sign materials 673
Post-tensioning methods, precast prestressed concrete members 316, 317, 321–323
Posts:
Cattle guard 459
Concrete end, paint for 656

Posts—*continued* PAGE
Construction sign 552
Fencing 453–456
Guardrails 461, 462
Line 455, 691–693
Metal fence materials 692, 693
Metal marker 467, 470
Object markers and guide 685
Removal of 99
Right of way markers 467
Sign posts 561, 673–675
Steel pipe for 673–675
Temporary sign 555
Timber 372, 655
Wood 674, 683, 691, 692
Pozzolan used in Portland cement 605, 609
Precast:
Concrete piles 377–379, 383
Manholes 427
Prestressed concrete members (see Prestressed concrete members)
Precast concrete box culverts (see also Culverts) 309, 310
Preconstruction conference 67
Preformed elastomeric joint seal 298, 299
Prequalification of bidders and contractors 9
Preservative treatments for timber 451, 452, 462
Preservatives, timber 681
Pressed steel products, galvanizing of 657
Pressure:
Conduits, concrete and clay pipe for 641
Pipe, reinforced concrete for 402
Prestressed concrete members:
Anchorages and distribution 318, 319
Bonding and grouting 324, 325
Construction methods 316–327
Curing 323
Description 315
Ducts 319, 320
Forms 318
Handling 325
Materials 315, 317, 318
Measurement 327
Payment 327, 328
Post-tensioning 316, 317, 321–323
Prestressing methods 316, 317
Prestressing steel 317, 318, 320–323, 651–654
Pretensioning 316, 317, 321–323
Reinforcement and anchorages, testing of 653
Tolerances 325–327
Prime coat 225–227
Privilege taxes 49
Production sources, roadside 63
Profile grade, defined 5
Progress of work, prosecution and 63–72

PAGE
"Progress schedule" 64
Project, defined 5
Proof rollers 112
Property marks, protection and restoration of 55–57
Proportioning methods for:
Portland cement concrete 269–272
Portland cement concrete pavements 237–240
Roadbed modification 182
Proportions, classification and; Portland cement concrete 268–272
Proposal:
Change in staging of sequence of operations 19
Consideration of 15
Defined 6
Delivery of 12
Eliminated items from 81
Examination of 10, 11
Filing 12
Form, contents 9
Defined 6
Issuance required for acceptance of bid 9
Guaranty 12
Defined 6
Forfeiture of 12, 16
Return of 15, 16
Irregular 11, 12
Preparation of 11
Public opening of 12
Quantities, interpretation of 10
Rejection of 12, 13, 15
Requirements and conditions 11, 12
Return to bidder 12
Signatures 11
Withdrawal or revision of 12
Proposal, value engineering 29–31
Prosecution and progress of work 63–72
Protection:
And curing (see Curing)
Archeological and paleontological objects and artifacts 39, 56
Existing facilities 149
Forest 57
Of pavement 254, 255
Of poles 55, 56
Portland cement concrete 266, 268
Prestressing steel 317, 318
Property and landscape 55–57
Surface natural resources and improvements 39
Trees and shrubs 55, 56, 91
Pruning, landscaping 147
Public, convenience and safety (see also Accommodations for public traffic) 50, 51
Construction and temporary signs for safety of 551–557
Officials, personal liability of 55, 61
Public land, source of material located on 35–39

PAGE
Public Service Commission 471
Pumping concrete 292
Pumping water 290

Q

Qualification of bidders 9
Quality of materials and source of supply 33
Quantities, altered (see also Increased or decreased quantities):
Change order, defined 2
Interpretation of 10
Measurement of (see also sections for various items of work) 73–78
Quick coupler valves, irrigation systems 155, 156

R

Rail:
Barrier rail, concrete structures 307–309
Bridge, aluminum alloy used in 647
Elements, galvanizing of 657
Members, guardrail materials 683
Posts 364, 365
Finishing of 348
Precast concrete barrier rail 551–554
Standard metal, paint for 655, 656
Railing:
Steel bridge, paint for 655, 656
Steel structures 346
Timber bridge, paint for 655
Railroad crossing defined 51
Railroads (see also Utility property and services):
Clearance markers 52
Concrete forms over or in vicinity of 282
Contractor's responsibility for property 59, 60
Employees' services 52
Flagging protection 52
Movement or adjustment of telephone, telegraph or signal facilities 52, 53
Pay rates 52
Protective liability and property damage insurance 53, 54
Rules and regulations with respect to highway contractors 51–53
Work or operations performed by 52, 53
Ramps, concrete 439–443
Ready-mixed concrete 273–275
Reaming, steel structures 349, 350, 352
Recycled plantmix bituminous surface 208, 209
Reflector plates, guardrail 684
Reflectorization of:
Guardrails 684
Portable precast concrete barrier rail 309, 552
Signs 51, 551, 552, 559, 560
Traffic beads 719, 720

PAGE
Reflectors, object markers and guide posts....465, 686
Guardrails....684
Refund of motor fuel tax....13
Reinforcement:
Bar steel....651
Cold-drawn steel wire for spiral reinforcement....654
Concrete....289, 651–654
Fabricated steel bar or rod mates....651
Materials covered....651
Pavement reinforcing fabric....721
Physical properties and tests....651–654
Portland cement concrete pavement....244
Prestressing steel....316–327, 651–654
Welded steel wire fabric....651
Reinforcing fabric, pavement....189, 202, 203, 721
Reinforcing steel....335–344, 385
Relay culvert pipes....407
Removal of....99
Relief from maintenance and responsibility....58, 59
Removal of structures and obstructions (see also Disposal of materials; types of structures and obstructions)....97, 100
Abandoned pipe lines....97–99
Bituminous pavement....98, 106, 107
Bridges....97
Brush....34, 91–95, 453
Buildings....93, 97
Catch basins....98
Closing culverts....98, 99
Construction methods....97–100
Culverts....97–99
Curbs, gutters and sidewalks....98
Description....97
Disposal of materials....99, 100
Drainage structures....97
Falsework, forms and housing....294–296
Fences....93, 97
For reuse....99
Foundation excavation....121–130
Foundations....93, 97
Gates for reuse....99
Guardrail....97
Designated for reuse....99
Guide posts....97
Designated for reuse....99
Manholes, catch basins and inlets....98
Measurement....100
Non-perishable material....97
Object markers....97
For reuse....99
Objects or disturbances caused by contractor's operations....20, 21
Pavements....98, 106, 107
Payment....100

Removal of structures and obstructions—*continued* PAGE
Perishable material 97
Roots 91–95
Rubbish 20, 21, 149
Salvable material 97
Salvage from 99
Structural steel specified for salvage 99
Structure excavation material 121, 122
Stumps 91–95
Substructures of existing structures 98
Temporary signs and barricades 556
Timber or piling designated to be salvaged 99
Trees 91–95, 453
Unacceptable and unauthorized work 27
Underground structures 55–57
Unsuitable material 20, 21, 102, 113
Rental of equipment:
For accommodating traffic 547
Force account work 80, 81
Measurement and payment 76, 77, 547–549
Reset object markers and guideposts 465, 466
Resident Engineer, authority and duties of 23, 26, 57
Restoration of property and landscape 55–57
Surfaces opened by permit 49, 50
Restrictions, load and speed 28
Retaining walls
Masonry block 583, 584
Measurement 589, 590
Mechanically stabilized earth wall 584–589
Payment 590
Retaining walls, metal bin-type 437, 438
Backfill for 127
Retempering of Portland cement concrete 275
Return of proposal guaranty 15
Reuse of materials after removal of structures 99
Riding tolerances, Portland cement concrete pavements 252, 253
Right of way:
Clearing and grubbing 91–95
Defined 6
Delays 25, 71
Furnishing of 61
Right of way markers 467
Paint for 655
Timber, quality requirements of 679
Rights in materials found on work 20
Riprap 429–432
Materials 636
Riprap structures:
Construction (Useable materials from old structures) 99, 100
Downdrains 421
Road, defined 6
Roadbed, defined 6

PAGE
Roadbed modification....181–184
Compacting and finishing.... 183
Construction methods....181–183
Curing.... 183
Description.... 181
Gradation requirements.... 181
Materials.... 181
Measurement....183, 184
Mixing....182, 183
Payment.... 184
Preparation of roadbed.... 181
Proportioning.... 182
Protection and curing.... 183
Watering....182, 183
Weather limitations.... 181
Roadmix bituminous surface (see also Bituminous roadmix surface)....215–222
Roads in ditch and dike areas....56, 57
Roadside, defined.... 6
Development, defined.... 6
Roadside materials (see also Erosion control; Irrigation systems; Landscaping)....699–703
Certificates and samples.... 699
Fabric, erosion control.... 701
Fertilizer, commercial....699, 700
Humus....699, 700
Irrigation materials.... 702
Masonry.... 703
Mulch....700, 701
Pipe and pipe fittings....699, 702
Plants....699, 701
Production sources....699–703
Requirements....699–703
Scope.... 699
Seeds....699, 701, 702
Topsoil....699, 700
Tree ties.... 702
Roadside signs....551, 552
Roadway:
Construction, drainage during.... 105
Defined.... 6
Bridge roadway width, defined.... 2
Excavation and embankment....101–116
Overhaul on....114, 119, 120
Failure to maintain.... 28
Grading....101, 102
Rock cuts in excavating....102, 103
Rock embankment compaction:
Construction methods.... 110
Equipment....110–112
Testing....110, 112
Rock embankment placement....108, 109
Rock materials, measurement for....113, 114
Rod mats reinforcement, for concrete.... 651

PAGE
Rolled material; straightening of ... 349
Defects ... 645
Rolled steel products, galvanizing of ... 657
Rollers and rolling (see also Compaction):
Breakdown ... 197
Finish ... 198
Plantmix bituminous base ... 169
Plantmix bituminous open-graded surface ... 211, 212
Plantmix bituminous pavements ... 197, 198, 201, 202
Plantmix bituminous surface ... 207
Pneumatic-tired ... 111, 112, 197, 198
Proof rolling ... 110, 112
Roadmix bituminous surface ... 216
Sheepsfoot or tamping ... 110, 111
Spreading mulch ... 138
Surface treatment ... 231, 233
Roots, removal of ... 92, 93
Round timber piles ... 677
Rounded and transition slopes ... 117, 118
Rubber gasketed joints, reinforced concrete pipe ... 402
Rubber gaskets ... 637
Rubbish, removal of (see also Clearing and grubbing) ... 20, 91–95, 149
Rural clearing (see Clearing and grubbing)
Rural Electrification Association ... 471

S

Safety and health provisions ... 50
Safety precautions, contractor's compliance with ... 50, 51
Salvaging of materials:
From removal of structures ... 99
Structural plate pipe and pipe arch culverts ... 411
Sampling and protection of Portland cement concrete ... 266, 268
Samples and tests (see also sections covering various items of work) ... 43–46
Sand blotter:
Aggregates for bituminous courses ... 630
For prime coat ... 225–227
For seal coat ... 229, 230
Sand for grout and mortar ... 635, 636
Sanitary provisions ... 50
Scales, requirements for ... 74, 75
Conveyor ... 74, 75
Plant ... 191, 204
Platform ... 74
Scalping for clearing and grubbing ... 93
Schedule, progress ... 64
Scope of payment ... 78, 79
Scored shoulders ... 211, 212
Screenings, aggregates for bituminous courses ... 630
For surface treatment ... 231, 233
Seal coat ... 229, 230
Seed beds, landscaping ... 144

	PAGE
Seeding and fertilizing:	
Erosion control	137, 138
Landscaping	146
Seeds, erosion control	135
Quality requirements	699, 701, 702
Selected material, base or surface	163, 164
Selected material encountered in excavating	104
Measurement for	114
Sewers:	
Concrete and clay pipe and drains for	641
Connections, non-reinforced concrete and clay pipe	397, 398
Live, treatment of when abandoning manholes, catch basins and inlets	98
Shaping Portland cement concrete pavement	245–247
Shear connector studs	353, 354, 646
Sheepsfoot or tamping rollers	110, 111
Sheet aluminum (see Aluminum sheets)	
Shims, aluminum alloy	647
Shop assembly, steel structures	352, 353
Painting	364
Shoulder, defined	6
Shouldering material	185
Shoulders, scored	211, 212
Sidewalk (see also Curbs, gutters and sidewalks):	
Defined	6
Sign:	
Background	552, 555, 559, 560, 659–671
Faces, preparation of	560, 670, 671
Illumination	495, 496, 530–532, 534, 538, 539, 541–543
Islands	560, 561
Sign materials	659–675
Sign posts (also see Posts)	552, 555, 561, 671–675
Signals and lighting:	
Auxiliary equipment	502–506, 514–516
Back plates	519
Ballasts	474, 483, 491, 492, 527–529, 531, 532, 537, 538, 540
Bonding and grounding	471, 472, 481, 483, 485, 492, 493, 496, 503, 522
Conductor table	487, 488
Conductors	471, 480, 485–492, 494, 520, 522–525, 532, 535, 536, 539
Conduit	480–483, 492–494, 497, 541–543
Controller:	
Auxiliary movement	475
Conflict monitor	505, 506
Construction	501, 502
General	472, 474–476, 491, 498–516, 533, 535, 540
Housing	490, 497, 502–506, 509–511, 515–518
Phase module description	500, 501
Vents	516
Controllers:	
Pre-timed	475, 498, 513–516
Traffic actuated	476, 500–513, 520–524
Definitions	474–476
Description	471–476
Detector foundations	476, 477, 524

Signals and lighting—*continued* PAGE
Detectors....520–524
Raising or relocating existing pressure-sensitive.... 524
Directional louvers.... 518
Equipment list and drawings....471, 472
Excavating and backfilling.... 477
Existing and temporary electrical systems, maintaining....472, 473
Expansion fittings.... 485
Falsework lighting....538–540
Field tests....473, 495, 496
Flasher beacons.... 533
Flashers....474, 475, 515, 533, 541
Flashing operations....474, 475, 496, 498, 499, 503–505, 512, 514–516
Foundations....476, 477
Galvanizing....479, 496, 497
Junction boxes.... 484
Local traffic computer system coordination equipment....510–513
Luminaires:
General....527–530
High-intensity-discharge....527, 528
High pressure sodium.... 529
Incandescent.... 529
Mercury vapor....528, 529
Soffit and wall mounted....529, 530
Maintaining existing and temporary electrical systems....522, 523
Mast arms.... 479
Materials....476, 477
Measurement.... 541
Mounting brackets.... 519
Multiple circuit ballasts....532, 537, 538
Operating voltage.... 499
Optical units....517, 525, 526
Painting....497, 498
Partial payments on.... 86
Parts lists, instruction sheets and.... 472
Payment....541–543
Pedestrian push buttons....499, 524, 525
Signal faces....475, 516–518, 526, 527
Signals, "Walk-Don't Walk"....524–526
Photoelectric controls....526, 527, 533–535
Pre-timed controllers....475, 498, 513–516
Pull boxes....483–485
Push button posts and guard posts.... 479
Radio interference suppressor.... 499
Railroad pre-emption....498, 499
Regulations and code.... 471
Reinstalling salvaged electrical equipment....540, 541
Removing and replacing improvements....477, 478
Safety precautions.... 474
Salvaging electrical equipment.... 540
Scheduling of work....473, 474
Series circuit ballasts:
Lighting conductors.... 532
Multiple transformers....535–537

Signals and lighting—*continued* PAGE
Service locations and installations....493–495
Sign fixtures, fluorescent....530–532
Sign switches....532, 533
Signal faces....475, 516–518
Signal head mounting....519
Standards, steel pedestals and posts....478–480
Stockpiling salvaged electrical equipment....541
Time base coordination unit....513
Traffic pre-empting devices....506–510
Warranties and guarantees....472
Wiring....489–492
Wood poles....495
Signs and barricades, partial payments on....553, 554
Signs, construction:
Construction methods....552, 553
Contractor's responsibility....551
Description....551
Foundations....552
Lights for....553, 554
Materials....551
Measurement....553
Mounting....552
Partial payments on....85, 553, 554
Payment....553, 554
Public convenience and safety....50, 51
Reflectorization of....551, 552
Removal of....551, 552, 554
Rental of....551, 553
Roadside signs....552
Signs, permanent:
Aluminum sheet panels....559, 560
Background....559, 560
Construction methods....560, 561
Description....559
Fabrication....559, 560
Frame supporting....559–561
Installation....560, 561
Islands....560, 561
Materials....559, 560
Measurement....561, 562
Payment....562, 563
Quality requirements....559, 560
Reflectorization....559, 560
Removal....561
Reset....561
Shop drawings....559
Sign background....559, 560
Sign faces....559, 560
Sign islands....560, 561
Tests....561
Signs, temporary:
Background....555

Signs, temporary—*continued* PAGE
Barricades and markings....555, 556
Construction methods....555, 556
Description....555
Installation of....556
Materials....555
Measurement....556, 557
New signs, partial payment on....557
Payment....557
Public convenience and safety....50, 51
Removal and re-erection of....556
Sign faces, preparation of....555, 556
Sign posts....555
Specifications covering materials used in....555
Sills, timber construction....371, 372
Siphons, concrete and clay pipe....641
Corrugated metal pipe and metal arch pipe....406, 407
Reinforced concrete pipe....402, 641
Site of work, examination of....10, 11
Site preparation, landscaping....143
Slabs, concrete structures....291, 292
Precast prestressed concrete (see Prestressed concrete members)
Slides and slipouts, excavation and removal of....104
Measurement for....114
Slopes:
Cultivation of....136
Excavation and embankment....103
Paving, concrete....433–435
Rounded and transition....117, 118
Slotted corrugated metal pipe drains....407
Snap couplers, split couplers, spin-on couplers....421
Society of Automotive Engineers....2
Sources of local material....35–42
Of supply and quality requirements....33
"Special detours," payment for....19
Special provisions:
Coordination of plans, specifications, supplemental specifications, and....24
Defined....6
"Specialty items" for contract....63
Specifications (see also Plans and specifications):
Cited....45, 46
Conformity with....24
Coordination of....24
Defined....6
Examination of....10, 11
Interpretation of plans and....23, 24
Preference, order of....24
Repetition of expressions, avoidance of....8
Supplemental....7
Speed restrictions, load and....28, 65
Spikes, timber structures....373
Splices, reinforcing steel....338, 342
Steel structures....349, 350

PAGE
Spray nozzles, irrigation systems 161
Spreading and finishing (see also Finishing):
Aggregate base courses 165, 166
Plantmix bituminous pavements 200, 201
Plantmix bituminous surface 207
Portland cement concrete pavement 245–247
Portland cement treated base 174–176
Roadmix bituminous surface 219
Sprinklers:
Connections 159
Heads 154
Irrigation systems 160, 161
Stainless steel bolts 645
Stakes, construction, lines and grades, preservation of 26
Staking and guying of plants 147
Standard steel 645
Standards:
Federal Specifications and Standards 1
Fencing, metal gates for 694
Metal rail, paints for 655, 656
United States of America Standards Institute 2
Staples, brace wire and nails 694
State, defined 7
State-furnished materials 47
Steam cleaning, painting 447
Steel (see also Structural steel):
Bridge railing, paint for 655, 656
Guardrail materials 683, 684
Joints, concrete structures 296
Light standards, paint for 655
Paint for structural steel 448, 449
Piles 388, 649
Pipe for posts 673–675
Tubular, fence material 692, 693
Welded seamless 645, 671, 672
Plates, edge planing 353
Surface finish 353
Prestressing (see Prestressed concrete members)
Reinforcing (see Reinforcing steel)
Rolled material, straightening of 349
Sheets, for object markers and guide posts 685, 686
Guardrail construction (Reflector plates) 684
Shell for piles 383, 649
Standard 645
Steel structures:
Abutting joints 353
Annealing and stress relieving 363
Bearing and anchorage 365
Beginning of work, notice of 347
Bolts and bolted connections 350–352
Bolts, nuts and washers, material requirements 346
Construction methods 346–366

Steel structures—*continued* PAGE
Description 345
Drawings, shop 346, 347
Edge planing 353
Elastomeric bearing pads 365, 695–698
End connection angles 353
Erection methods and equipment 364, 365
Facing of bearing surfaces 353
Falsework 365
Field assembly 366
Field painting 366
Flame cutting 353
Inspection and testing of 347, 348
Lacing bars 353
Marking and shipping 364
Materials 345, 346
Measurement 366, 367
Misfits 366
Paint for iron and steel use items 655
Painting (see also Structural steel) 364, 366
Payment 367, 368
Piles 388
Pins, rollers and pin holes 363, 364
Punching, subpunching, drilling and reaming 349, 350, 352
Rail posts, erection 364, 365
Finishing 348
Railing 346
Rolled material, straightening of 349
Rollers 363
Shipping members 364
Shop assembly 352, 353
Shop painting 364
Stiffeners, fit of 363
Storage of structural material 348
Stress relieving, annealing and 363
Stud shear connectors 353, 354
Weights, calculated 366, 367
Welding 354–363
Stiffener plates, galvanizing of 672, 673
Stiffeners, fit of, steel structures 363
Stone for masonry and riprap 636
Storage of:
Aggregates, lightweight concrete 330
Explosives 54, 55
Materials 46
Materials near railroad tracks 51, 52
Plants, landscaping 142, 143
Portland cement concrete aggregates 268
State paid for or furnished materials 59
Structural steel materials 348
Timber and lumber 370
Storm drains, concrete and clay pipe for 641
Straightening, rolled structural steel materials 349

INDEX

PAGE

Straps, bars and braces for signs 674
Straw mulch materials 700, 701
Stream channels (see Ditch and channel excavation)
Street, defined 7
Stress relieving, steel structures 363
Stringers for signs 674
  For timber structures 372, 373
Strip products, galvanizing of 657
Striping (see Pavement markers)
Structural steel:
  Bridge structures, requirements 646
  Cold-formed welded and seamless carbon structural tubing in rounds and shapes 646
  Defects 645
  High strength bolts 645
  High-strength, low-alloy columbian-vanadium steel 645
  High strength low-alloy steel 646
  High-yield strength alloy steel 646
  Paint for 655
  Painting 448, 449
  Partial payments on 83
  Physical properties and tests 645, 646
  Pins and rollers 646
  Salvage 99
  Shear stud connector 646
  Stainless steel bolts 845
  Standard steel 645
  Surface preparation 446–448
  Tubing 646
  Weights 366, 367
  Welded seamless steel pipe 645
Structural timber, quality requirements for 679
Structures and obstructions, removal of (see also Removal of structures and obstructions) 97, 100
Structures, concrete (see Concrete structures)
Structures, defined 7
Structures, excavation for 121–123
Structures, steel (see Steel structures)
Structures, timber (see Timber structures)
Strutting corrugated metal pipe 406
Strutting structural plate pipe 414
Stud shear connectors, steel structures 353, 354
Stumps, removal of 92–95
Subcontractor:
  Claims against 55, 56
  Contract, subletting 63, 64
  Contractor's liability for claims against 63
  Defined 7
  Fair Labor Standards Act, observation of 50
  Liability insurance 53, 54
  Payroll and statement of compliance, submission 49

	PAGE
Subgrade:	
Cement treated	605
Defined	7
Material, watering for	133, 134, 687
Preparation, aggregate base courses	165
Selected material base or surface	163
Subletting of contract	63, 64
Subpunching, drilling and reaming	349, 350, 352
Substitute methods of types of equipment	66
Substitution of plants, landscaping	143
Substitution of reinforcing steel	343
Substructure, defined	7
Substructures of existing structures, removal and disposal of	97
Subsurface information	10, 11
Superintendent:	
Authority and duties	24, 25
Defined	7
Supplemental agreement	17
Defined	7
Supplemental specifications:	
Defined	7
Examination of	10, 11
Supply of materials, source and quality	33
Surety, defined	7
Responsibility of	69, 71
Surface course, defined	7
Surface natural resources and improvements, protection of	39
Surface tolerances (see also Tolerances)	687
Surface treatment:	
Aggregate spreader	231
Application of bituminous material	232, 233
Application of screenings	233
Distributors	231
Maintaining traffic during	231, 232
Materials	231
Measurement	233
Payment	234
Preparation of surface	232
Rollers	231
Rolling	233
Screening	231, 233
Water for, quality of	687
Weather limitations	231
Surfaces:	
Existing (see Existing surfaces)	
Opened by permit, restoration of	49, 50
Selected material for (see Selected material, base or surface)	
Treatment of (see also Surface treatment)	231–234
Surfacing:	
Bituminous plantmix pavements	187–205
Bituminous roadmix surface	215–222
Materials, watering of	133, 134
Miscellaneous areas	202, 219

PAGE
Surplus excavated material....103, 104
Measurement and payment....114
Survey monuments....469, 470
Suspension of work (see also Work):
Contractor's responsibility during....59
Temporary....66, 67

T

Tack coat....223, 224
Tackifier used as tie-down for mulch....136, 138
Tamping rollers, or sheepsfoot....110, 111
Target members....465
Target plates:
Base metal....685
Paint for....686
Tax refund, motor fuel....13
Taxes, permits, licenses and privilege....49
Television cable companies, protection of property....59, 60
Telltales, installation of....52
Temporary pollution control (see Pollution control)
Temporary signs (see also Signs, temporary)....555-557, 659-675
Temporary suspension of work....66, 67
Termination of contract and contractor's responsibility....69-71
Terms and definitions....1-8
Test methods for:
Aggregates for bituminous courses....627-630
Aggregates for Portland cement products....631-636
Base aggregates....623-626
Bituminous materials....611-622
Compaction of rock embankment....110-112
Joint material....637-639
Lightweight concrete....329, 330
Load testing....381, 382
Materials....43-46
Paints....655, 656
Pavement marking film....571
Permanent signs....561
Plant materials....142
Portland cement concrete....263, 264
Portland cement concrete pavement....235-237
Prestressing reinforcement and anchorages for concrete....651-654
Studs....353, 354
Supply lines, irrigation systems....160, 161
Traffic paint....717, 718
Water....687
Test piles....377, 378
Payment for....389
Testing methods by Department of Transportation....45, 46
Thickness requirements, concrete pavements....256-258

Timber: PAGE
- Certificates of inspection 679
- Grades 679
- Measurement 75
- Merchantable 93
- Paint for 655
- Painting 449
- Preservative treatments for (see also Preservative treatments for timber) 451, 452
- Preservatives 681
- Quality requirements 679
- Salvage 99
- Species 679

Timber piles 382, 383
- Caps 382
- Heads of 382
- Specifications of rounded piles 677
- Treated 370, 371

Timber posts 372
- Guardrail posts 461, 462
- Preservatives 451, 452, 681
- Quality requirements 679
- Sign posts, paint for 655
- Temporary signs 555–557
- Wood posts 691, 692

Timber structures:
- Bolts and washers 371
- Bracing 372
- Caps 372
- Cattle guards (see Cattle guards)
- Circular grids 370
- Connectors 369, 370, 374
- Construction methods 370–374
- Description 369
- Framing 372
- Glued laminated timber 369
- Guardrail (see Guardrails)
- Holes for bolts, dowels, rods and lag screws 371
- Inspection of timber 452
- Laminated floors 373
- Materials 369, 370
- Measurement 374
- Painting 374, 449
- Paints 655
- Payment 374, 375
- Piles (see Timber piles)
- Plank floors 373
- Posts (see Timber posts)
- Preservative treatments for 451, 452, 681
- Shear-plate connectors 369, 370, 374
- Spike-grid timber connectors 370, 374
- Split ring connectors 369, 374
- Storage of materials 370

Timber structures—*continued* PAGE
Stringers....372, 373
Structural timber and lumber, quality requirements....679
Treated timber and piling....370, 371
Trusses....373, 374
Untreated timber....371
Workmanship....370
Timber use items, paint for....655
Time:
Appeal from decisions of Engineer....23
Award of contract....15, 16
Commencement of work....64
Completion of contract....67–69
Contract time, defined....3
Extension of contract....56, 67–69, 71
Failure to complete work on....69
Return of guaranty....16
Working day, defined....8
Working drawings, submission to Engineer....23
Tolerances:
Aggregates, type 2, class A....167
Elastomeric bearing pads....697
Piles....384
Plantmix bituminous base....169, 170
Plantmix bituminous surface....208
Plantmix open-graded surface....212
Precast prestressed concrete members....325–327
Riding, Portland cement concrete pavements....252, 253
Roadmix bituminous surface....219, 220
"Ton," meaning of....73, 74
Topsoil:
Erosion control....135–137
Excavation of local materials, removing and relaying topsoil....33–35
Material requirements....699, 700
Placement of....136
Traffic beads....719, 720
Traffic control:
Construction signs....551–554
Lane, defined....8
Maintenance (see Maintenance—Of traffic)
Manual on Uniform Traffic Control Devices....2
Permanent signs....559–563
Public convenience and safety....50, 51
Restriction on use of surfaces....65
Temporary signs....555–557
Traffic paint (see also Paint materials)....713–718
Transition slopes, rounded and....117, 118
Transverse expansion joints:
Portland cement concrete pavements....247–251
Sidewalks....440
Traveled way, defined....8
Treated timber and piling....370, 371

PAGE

Tree ties:
- Landscaping ... 147
- Materials requirements ... 702

Trees and shrubs:
- Excavation adjacent to ... 158
- Landscaping ... 141–151
- Protection of ... 55, 56, 91
- Removal of ... 92–95

Tremie for concrete deposited under water ... 292, 293
Trenches, backfilling ... 97
- Restoration of area ... 20, 21
- Underdrain outlets ... 418

Truck mixers or agitators, Portland cement concrete ... 273–275
Trusses, timber structures ... 373, 374
Tubing:
- Aluminum alloy ... 647
- Carbon steel structural ... 646
- Control tubing, irrigation systems ... 160
- Steel structure ... 646

U

Unacceptable and unauthorized work ... 27
Unacceptable materials ... 46, 47
Underdrains ... 417–419
- Backfill for ... 131, 132, 417, 418
- Materials for ... 641, 644

Underwriters' Laboratories, Inc. ... 2, 471
United States of America Standards Institute ... 2
Unsuitable material:
- Excavation and embankment ... 102
- Measurement for payment ... 113
- Perishable, destruction of ... 97
- Removal of ... 20, 21, 52, 102

Unsuitable weather, temporary suspension of work due to (see also sections covering various items of work) ... 66, 67
Untreated timber ... 371
Urban clearing (see Clearing and grubbing)
Utility property and services:
- Contractor's responsibility for ... 59, 60
- Cooperation of contractor with ... 25
- Delays to contractor from removing and relocating of ... 25
  - Compensation for ... 25
- Inspection of work by ... 27
- Railroads (see Railroads)
- Restoration of surfaces opened by permit ... 49, 50
- Right of way delays ... 25
- Underground facilities not known to State ... 25

V

PAGE
Vacuum breakers, irrigation systems....156, 157
Value engineering proposals....29–31
Valve boxes, irrigation systems....156
Valve protection sleeves....154
Valves, quick coupler, irrigation systems....155, 156
Vanadium steel, columbium-....645
Vibrators for concrete structures....290, 291
Vibrators for Portland cement concrete pavement....242, 243
Vibratory compactors for excavation and embankment....112
Volumetric measurements....76

W

Wages and conditions of employment....89
Waiver of legal rights....61, 69
Walk gates, fence materials....694
Warning signs (see also Signs, construction)....51, 551–554
Warranties, manufacturer's....33
Washers:
- Cast....689
- Flat malleable....689
- Galvanizing of....657, 689
- Signs....672–675
- Steel structures....346
- Timber structures....371

Water:
- Meters....73
- Pollution control....57
- Pumping, concrete structures....290
- Quality of....687
- Retardants....607–609
- State-owned, for irrigation systems....147, 148

Watering (see also sections covering various items of work)....133, 134
Waterproofing and dampproofing:
- Asphalt for....591, 611
- Construction methods....591, 592
- Description....591
- Materials....591
- Measurement....592
- Payment....592

Waterproofing, bridge deck:
- Construction methods....595–599
- Description....593
- Materials....593–595
- Measurement....599
- Payment....599, 600

Waterstops:
- Concrete structures....297
- Material requirements....637, 638

Weakened plane joints, Portland cement concrete pavements....248, 249

PAGE
Wearing course, defined 7
Weather conditions, temporary suspension of work due to (see also sections covering various types of work) 66, 67
Weighing of materials (see also sections covering various items of work) 73–75
Weights of:
Asphalt cement 76
Asphaltic emulsions 76
Liquid asphalt 76
Reinforcing steel 343
Structural steel 366, 367
Weldability tests, stud shear connectors 353, 354
Welded and seamless carbon steel structural tubing 646
Welded seamless steel pipe 645
Welded steel wire fabric reinforcement 651
Welding materials 649
Welding steel structures 354–363
Widening cuts, excavation of 103
Payment for 114
Wingwalls, placing and compacting at 126
Wire:
Barbed 455, 693
Brace 694
High-tensile steel wire 651–654
High-tensile wire strand 651–654
Mesh 693
Woven 455, 693
Withdrawal or revision of proposals 12
Wood cellulose fiber mulch 701
Wood chips and shavings, mulch 701
Wood posts (see also Timber posts) 674, 683, 691, 692
Work:
Cancellation of work from contract 18
Change in character of work 17, 18, 29–31
Character of workmen; methods and equipment 65, 66
Completion of portions of the work 58, 59
Contractor's responsibility for 59
Control of 23–31
Day, defined 8
Default and termination of contract 69–71
Defined 8
Eliminated items 81
Examination of plans, specifications, contract documents, and site of work 10, 11
Extra (see "Extra work")
Failure to complete on time 69
Force account (see Force account work)
Increased or decreased quantities 17, 18, 29–31
Inspection of 26, 27, 46
By Chief Engineer (railroad) 51
By Engineer 28, 29, 46
By Federal agency 50
Limitation of operations 26, 64, 65
Maintenance 28

Work—*continued* PAGE
Measurement and payment (see also sections covering various items of work) 73–87
Methods and equipment 65, 66
Notice to proceed 5, 64
Preconstruction conference 67
Prosecution and progress 63–72
Schedule 64
Rejection of work 27
Relief from maintenance and responsibility 58, 59
Removal of unacceptable and unauthorized 27
Rights in and use of materials found on the work 20
Scope of 17–21
Subletting of contract 63, 64
Superintendent, authority and duties 24, 25
Suspension of work 19, 23, 26, 59
Temporary suspension of 66, 67
Value engineering proposals 29–31
"Working day" 64, 67
Defined 8
Working drawings:
Contents 23
Defined 8
Furnished by contractor 23
Signals and lighting 471, 472
Submission and approval 23
Workmen:
Character of 65, 66
Health, safety and sanitary provisions 50
Idle time 71
Parking private vehicles 65
Wages and conditions of employment 89
Workmen's Compensation Act 55
Woven wire 455, 693